

JULY



1950

No. 20

ORGAN OF THE MUSHROOM GROWERS' ASSOCIATION

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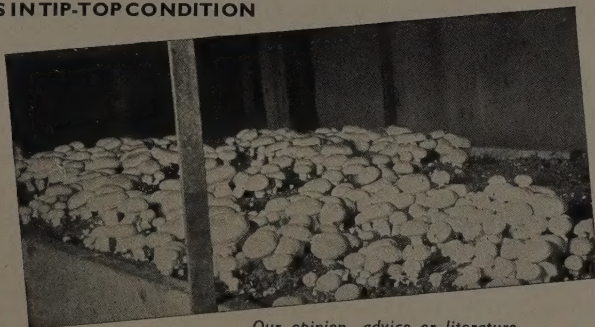
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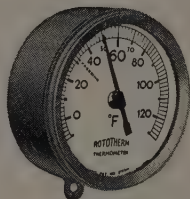
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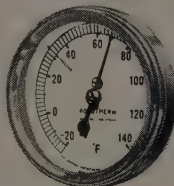
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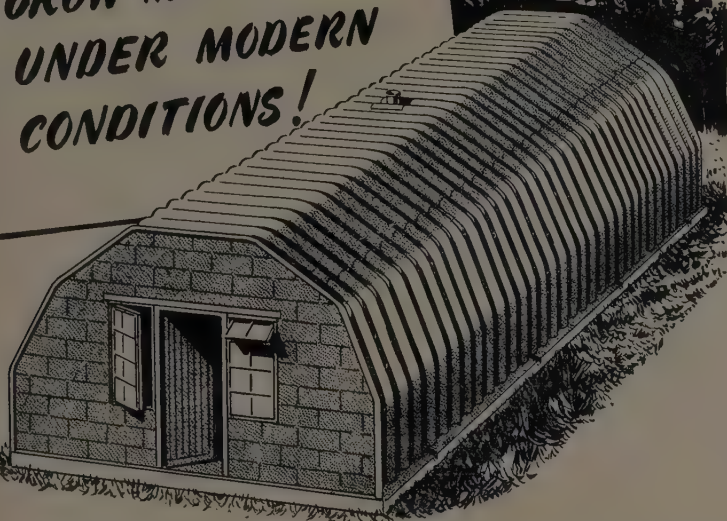
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No responsibility can be accepted by the Editor, the Editorial Board, or the Mushroom Growers' Association, for statements made or views expressed in this Bulletin, or for any advertisements included in this publication.

INCOME TAX RELIEF

A matter of considerable importance has been thrashed out by the M.G.A. working in close conjunction with the N.F.U.

In April, a member of the Association informed us that he was experiencing difficulty with the Inland Revenue people over some buildings he had just erected. They suggested that the relief provided by Section 33 of the 1945 Income Tax Act applied to capital expenditure in "husbandry" but not on mushroom farms.

Now "husbandry" includes mushroom growing for de-rating purposes, but this was a different matter entirely, and one of great significance to our expanding industry, so we consulted N.F.U. Headquarters.

By a question raised in the House of Commons at the Committee stage, the Union had sought confirmation that for the purpose of the 1945 Act, "husbandry" did include horticulture. The Attorney-General confirmed this (Hansard, 15th May, 1945, Col. 2,378), saying that "husbandry covers all the vegetable products of the soil." Quite apart from the fact the mushroom is defined as a fungus and not as vegetable, could it be regarded as "a vegetable product of the soil"?

The Economics Department of the Union came in here, as a result of which we have now been informed that :

"The official view of Somerset House is that Section 33 allowances apply not only to buildings or works carried out on agricultural enterprises, but also on horticultural enterprises."

If your local Inspector of Taxes expresses doubt on this point, suggest he gets in touch with the Inland Revenue at Somerset House.

Section 33, in simplified language, means that if a grower expends money on mushroom buildings of any sort, *he is allowed the following year to charge against profits one-tenth of the cost of the buildings, and one-tenth every succeeding year until the whole has been allowed.*

YAXLEY, PETERBOROUGH, NORTHANTS. 'Phone : Yaxley 391*

MUTUAL AID

QUESTIONS AND ANSWERS COLLECTED BY THE SECRETARY

Q. How does one value a mushroom farm?

A. It depends on so many factors, but the value of an average farm might be based on 10/- per square foot.

Q. What temperature is necessary to ensure that the top soil is free from Fusarium? Can partial sterilisation insure this—such as the heat generated in a heat room (around 130° F.)?

A. The casing soil should be pasteurized at 140-150° F. for half-an-hour. The spores in the moister compost will be killed by peak heating at 120° F. inside half-an-hour.

Q. Would Sterlzal at 1 : 40 kill all fungoid growth on bed boards?

A. Newton, Chambers Ltd. claim that at this strength even Truffle spores are killed.

Q. I have started cultivating mushrooms on the floor of my cellars, but have been warned by two different authorities that it is likely to cause wet rot in the house. The cellars are entirely constructed of stone and there is no wood work in contact with the beds except for the boards enclosing the mushroom beds—which are, of course, temporary structures. What do you think?

A. We do not see how this will cause wet rot in the house. Growing in cellars is quite common practice, and no complaints have reached our ears prior to this.

Q. We are trying a new casing soil and find on a rough test this is acid, with a pH value of about 6. Can you inform us the amount of lime necessary to render this soil suitable for casing? We propose using carbonate of lime, and not hydrated lime, as we understand it is safer.

A. Add 28 lb. carbonate of lime to bring the soil's pH to 7.5—8.0. The disadvantage of hydrated lime is that before casing you should wait several weeks after mixing it with the soil.

Q. I want to insulate a Handcraft Hut. It has been suggested that I spray the walls with Vermiculite (exploded mica), but I find the process very expensive. What do you suggest?

A. You will find glasswool or aluminium foil placed between the outside sheets and the flat lining very much cheaper and quite satisfactory.

Q. How much poultry manure should I add to my long-straw manure?

A. Some growers use about 1 cwt. **dried** poultry guano to 1 ton racing-stable manure. If you propose to add **wet** poultry manure you should at least double this amount.

Q. What are the usual causes of lower poundage per square foot from the bottom beds in an orthodox mushroom house?

A. Most mushroom houses have ventilators at ground level, and cold air (particularly cold draughts) do certainly affect the bottom beds. In normal weather the average temperature in the house is around 58° F., which means the bottom beds are about 55° F., which is below optimum. Most growers heat with hot-water pipes placed just off the ground and against the walls, and the warmed air rising from them tends to miss the bottom beds. The same thing happens during "peak heating," when there is commonly a 10° F. variation between top and bottom beds. It is improbable that an accumulation of CO₂ is contributory; normal ventilation looks after that. The difference in yield is minimised by raising the beds a few inches off the ground to enable air to circulate beneath them, and by baffling the ground ventilators so that incoming air is dispersed before it can chill the beds. The bottom beds could also be made rather deeper than the others: (1) So that they peak heat more readily, and (2) In order to take advantage of the fact now established that the deeper the bed the higher the potential yield.

Q. Can you advise me as to any precautions I can take to combat eelworms?

A. It is generally agreed that pasteurizing both compost and casing soil at 130° F. for several hours will kill this pest.

Q. How can I avoid Brown Plaster Mould?

A. The suggested remedy is for you to turn four times at weekly intervals, filling two days after the last turn and then try to get a peak heat. Many growers vary the length of the latter in order to adjust the water content and to complete the composting process. If you have a good compost there is a strong chance that the mycelium will overcome the mould and an average crop result. Be careful particularly not to get your finished compost too wet, or packed too tight in the beds.

CORRESPONDENCE

WITHOUT TEARS : I have just received your Research Appeal letter. As you know, I personally am a New Boy to mushroom growing, but the necessity for something like the M.G.A. and the M.R.A. should be obvious to any grower—long-established or otherwise. At this stage I cannot afford a big donation, but what I intend to do is this—and I think you would do well to consider suggesting it to others, especially the small growers. I will send you a Banker's Order for 10/- a month. This is not large, but even £6 a year will be of some help, particularly if some dozen or more others do the same. By this means the money will be extracted painlessly. Doubtless many growers who might stagger away from a suggestion of a £10 donation might comparatively happily sign a Banker's Order for £1 a month.

(Signature withheld by request.)

SOIL ELEMENTS : You asked in the last Bulletin (p. 94) what was the "trace element" which caused early fruiting in Japanese soil. This matter was told me by the daughter of a scientist who was experimenting with boron and water cultures. He was supplied with a very small quantity of the material—but its name was not mentioned. This was quite a few years ago and, at 83 years of age, memory is not as good as it was. I expect to sail from London for Brisbane on the 9th April.

I. W. READ.

(*Bon Voyage*, MR. READ—EDITOR).

EELWORMS : We have no precise information on the thermal death point of the eelworm pest of mushrooms for the simple reason that we have never had enough living material with which to carry out tests. The nematode is not *Ditylenchus dipsaci*, the stem/bulb eelworm; though it is closely related to it, it is nearer to a species called *Ditylenchus intermedius*.

Dr. T. GOODEY, Head of the

Nematology Department at Rothamsted.

IS TURNING REALLY NECESSARY? A few months ago a finished compost was just short of requirements for completely filling a pair of houses, therefore we decided on a crude experiment which gave satisfactory results, although we would not care to institute the procedure as a standard practice. Each house remained with approximately 100 square feet of shelf unfilled. We had just received a consignment of very fresh manure derived from riding stables, and this we used to

complete filling our houses after heating to 150° F. in our sterilizer. The resultant yield from these experimental and untreated sections was equal to that obtained from the compost which had received standard treatment. Is this another method of the quick composting method? In a crude form it is certainly similar to the apparent method in America in conjunction with the Tray system whereby composting is carried out solely in the trays in the pasteurizing room. W. A. B. HARDING.

COSTING : In his article, "Counting the Cost," in Bulletin 15, Mr. Atkins makes no provision for interest on investment, depreciation and maintenance, apart from repairs and renewals which he put at 1½d. (on the basis of cost of production at 2/6 lb.) A farm turning out 30,000 lb. a year represents a capital of about £4,000 if it is properly equipped to give peak heat, with office, packing shed, store, boiler, hot water pipes, telephone, accessible site, water and electricity laid on. The charge for interest, depreciation and maintenance could not be less than 10%, or £400 a year. The incidence per lb. of mushrooms will be 3¼d. It is difficult to understand how the Americans have got their charges down to 9d. a lb. as Gahm told us at the lecture in Worthing last autumn. With manure at £3 10s. 0d. a ton and as high a yield as 225 lb. per ton the cost for manure alone will be 3·75d. The U.S.A. Bulletin on mushroom growing puts interest depreciation and maintenance at 2 cents lb. at pre-war prices. It must be 3 cents now. At the old rate of exchange this comes to 2d. Spawn is ¾d. The total thus comes to 6·5d. Allow another 1d. for all other charges, e.g., fuel, insurance, water, electricity, office, accountancy, incidentals and there is only 1½d. left for labour. Labour in the U.S.A. was costing 5/- an hour—now with the devalued £ 7/- an hour. It works out that 1 man hour produces 56 lbs. of mushrooms. On Mr. Atkins' figures the output per man hour is 1¾ lb. I note that Orritt in the last Bulletin claims that he and his father turned out 22,000 lb. of mushrooms a year. This gives a labour charge of 6½d. a lb. This roughly agrees with my experience if I could get 1½ lb. per sq. ft. Sinden in his article in Bulletin No. 9 puts cost at less than 8 cents, less than 5d. at previous rate of exchange. You excuse high incidence of labour costs on grounds that every job must be as well done as it is possible to do it, yet the Americans claim that the average yield is 2 lb. with men turning out tremendously more mushrooms per man hour. What is the explanation?

LT. COL. E. NOEL.

FOG NOZZLE : There have been frequent references in the Bulletin to the likelihood of uneven watering of mushroom beds. I understand that in the U.S.A. an appliance called a fog nozzle is employed. It is three inches long and is so constructed that streams of water are directed against each other and the streams are broken up into such fine droplets as to form a mist. The droplets are so fine that the water distribution on the beds is uniform. They also assist in maintaining the humidity of the house. Is there a similar appliance on the market here?

LT. COL. E. NOEL.

TREAT 'EM ROUGH : I have very little scientific knowledge, but having been growing both in this country and in Western Canada since 1928, I could hardly fail to have acquired a certain amount of practical

knowledge. I might also add that in spite of the work, worry and heart-aches involved I know of no other line of endeavour in which I would rather be engaged. However, my purpose in writing is to tell you of a crop we are now picking which was, I believe, through unavoidable circumstances unique so far as how *not* to do it. We are growing in a series of brick kilns, one pair of which is not in too good a state of repair; during the recent very hot and dry summer a good deal of damage was done to the roofs and ceilings. The beds were made in shelves totalling 2,400 sq. ft. on 20th October. I spawned on 26th October, at around 65° F.—and then the rains came. So heavy were they that the water came through not in drips but in streams, and in many places went right through the top and second shelves down to the bottom. I was nearly distracted, for it was too wet outside to effect repairs, and we still had to case. Our casing soil suffered just as badly in the storms, and the only way we could spread it on the beds was with the back of a garden rake, for it was a clay soil and pretty muddy. I mixed about 30% nitrate of chalk with it and managed the job somehow. To add to our difficulties, our heating system was being turned over from steam to hot water and was not available until the middle of December Well, I picked the first mushrooms 65 days after spawning and it is as good a looking crop as I have ever seen. I cannot help but wonder if the man who in a recent Bulletin asked if we were codling our crops too much did not have the right idea.

W. DUNBAR.

CONFERENCE THANKS : May I ask for a little space in your Bulletin to express, on behalf of all my scientific colleagues at the International Conference, our thanks to the M.G.A. for giving us such a magnificent start. Much of the value of such a Conference lies in the friendly personal exchange of opinion and experience, and this depends very much on the personal relation between its members. Nothing could have been better for this than the warm friendly atmosphere and the welcome given by Mr. Hovell and members of the M.G.A. Executive Committee. We owe to them and to the M.G.A. much of the goodwill which the Conference has established among mushroom scientists.

R. L. EDWARDS (*Honorary Secretary*),
International Conference on Mushroom Science.

Dr. C. J. La Touche : Since leaving the Mushroom Research Association Ltd., where he was microbiologist from 1945 to 1948, Dr. C. J. La Touche has been in the Leeds School of Medicine carrying out research work for the Medical Research Council on fungi causing disease in human beings. Recently a lectureship in Medical Mycology was established in Leeds University and applications for the post were invited. Dr. La Touche was the successful candidate, and mushroom growers throughout the country congratulate him and wish him well. He writes : " While the greater part of my research work and lecturing will be concerned with Medical Mycology, I shall also lecture to B.Sc. students on General Mycology. This means that I will be able to continue to take a practical interest in all branches of Mycology."

Fifth

A. G. M. & Luncheon

M^r. André L. Simon,
distinguished President of the Wine
and Food Society and gourmet of
international repute, has very kindly
consented to be the Guest of Honour
at our Fifth Annual Luncheon.

The Luncheon this year will be at the
Connaught Rooms, Great Queen
Street (off Kingsway), London
W. C. 2, at 12.30 p.m. on Wednes-
day, 4th October. Tickets are priced
at 12/6, and are obtainable from the
Secretary.

The Annual General Meeting will
follow at 2 p.m.

MUSHROOM PESTS

By

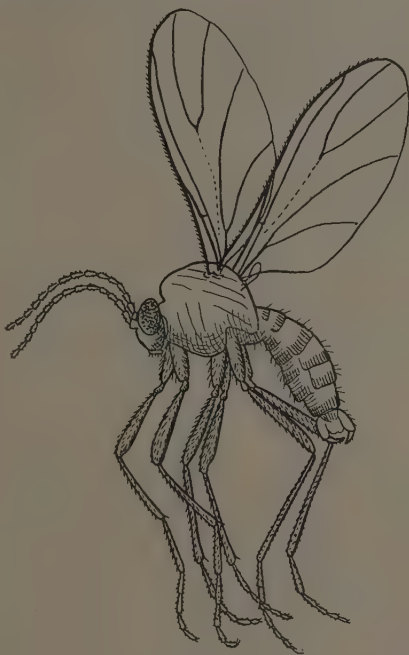
B. D. MORETON, B.Sc. Agric., Dip. Ent. (Wye)

There has been little research on mushroom pests in this country in the last 10 years, and it was natural that with the advent of the new insecticides during the war the greatest attention should be given to improving the control of the pests attacking the major crops. With the increased tempo of work stimulated by the period of emergency, there were advances made in five years that would have taken 10 or 20 in peace time: this served to accentuate the feeling that mushroom problems had been left behind. The object of this paper is to summarise present knowledge and to suggest some points most needing investigation.

SCIARID FLIES

The commonest pests are the flies, and the most important are the Sciariids and Phorids. The greater part of our knowledge of mushroom pests in Britain is due to the work of M. D. Austin and S. G. Jary, at Wye, in the early 1930's, and they identified six species of *Sciara* associated with mushrooms. These were *Sciara fenestralis*, *S. agraria*, *S. vivida*, *S. auripila*, *S. umbratica* and *S. varians*.

Sciariid larvae are white, legless maggots, with small, shining black head, and slender body about one fifth of an inch long when fully grown. Not only can they cause severe damage by extensive tunnelling in the stalk and cap, but also by feeding on the mycelium and possibly the spawn itself before it can run. If numerous they can greatly reduce the cropping of a bed; by cutting through mycelial strands they stop the production of buttons or cause these to become



SCIARID FLY

Sciara fenestralis (x 30)

brown and withered. As few as three to five larvae can be responsible for sufficient damage to spoil a mushroom; feeding is very rapid, and secondary decay soon sets in. The flies are delicate two-winged insects, about one twelfth of an inch in length, with black head and forebody and dark brown abdomen. The thread-like, many-jointed

antennae or " feelers " are nearly as long as the body and can easily be seen with a hand lens. The insects do not as a rule fly extensively but make characteristic short, jumping flights.

Life History

The life history of the various species is probably similar. That of *S. fenestralis* has been studied by Austin and Pitcher and is briefly as follows. Pairing of the flies occurs on the day of emergence, and the white, oval eggs are laid singly or in strings of 4-12, usually on the casing soil and the bases of the stalks, though occasionally on the cap; stumps of cut mushrooms left in the beds present very attractive sites for egg-laying. The eggs hatch in 4-7 days and the young larvae feed on the mycelium or bore into stalks and tunnel upwards. After feeding for 2-3 weeks the chrysalis stage is formed in the soil, in the larval tunnels, or between the gills, and this lasts for 1-2 weeks before the adult flies emerge.

Thus the whole life cycle from egg to adult can be completed under favourable conditions in one month, so that in the life of a bed there is time for 3 or 4 generations; with each female laying at least 30 eggs, it will be realised how easily a heavy infestation can be built up. Attacks can occur in any month of the year, and in addition to the damage caused by the larvae, the flies are also dangerous in that, as shown by Ware, they can sometimes carry on their legs the spores of *Verticillium*, and they can convey the migratory stages of some mites.

Source of Infestations

Although natural inhabitants of fungi and decaying organic matter, Sciariids are not necessarily always to be found in stable manure, their presence probably being determined by factors of local environment.



Left: SCIARID LARVA Centre . CECID LARVAE Right : PHORID LARVA (all $\times 15$)

Austin and Jary, making a study of the fauna of mushroom compost, found no Sciarids in two heaps regularly sampled throughout the composting period, but eggs, larvae and adults were numerous in several heaps sampled on the same farm the following year.

Larvae were even found in parts of the heaps where temperatures were as high as 158° F. and 162° F., though it was not known whether they would eventually survive such conditions. It was in fact shown that Sciarids became fewer after successive turns, and they were absent from samples taken towards the end of composting.

It appears likely from their observations that if composting is thorough, the outside of the heap being forked to the inside at each turn so that all parts of the material are subjected at some time to high fermentation temperatures, the final product should be practically free of Sciarids. The larvae would have limited powers of moving from hot to cooler regions. This seems to be supported by the experiences of growers, but the effect of the composting process on the fauna of manure is a subject worth further investigation, and should include observations on the lethal temperatures for various pests. If the compost is rendered almost free from certain pests at the outset, it should be possible to reduce the amount of insecticide that must subsequently be used ; in any case it is difficult to treat the compost once the beds are made.

Sciarids may enter the mushroom house either in the compost or by flying through ventilators, doorways or other openings. Where sub-soil is used for casing it is likely to be devoid of insect life and therefore not a source of infection, and it is assumed that the building is thoroughly cleaned out between crops.

Treatment of Compost

Observations have been published by the M.G.A. Insecticides Committee indicating that DDT can be used at quantities sufficient to have insecticidal value but not high enough to injure mushroom growth, though as conditions can vary so widely repeated experiments are necessary before definite conclusions can be drawn.

There is also the risk to the consumer to be considered since cases have been described in the U.S.A. where mushrooms have absorbed DDT ; and further, DDT is not always a very efficient destroyer of fly larvae. BHC (benzene hexachloride) is more toxic to many insects than DDT, it is less poisonous to man, and experience suggests that it is not taken up by the mushroom, so that it looks a more promising insecticide for mushroom work ; further it seems to have a deterrent action, and being more volatile exerts a fumigating effect.

Insecticides such as DDT and BHC are mixed with the compost by some growers (e.g., 2 lb. of BHC per ton). In Australia BHC dust has been mixed with the compost at rates as nearly as high as 1 lb. per cwt. without any taint or damage to growth.

If it is proved that insecticidal treatment of the compost is useful it will have to be shown that it is practicable to mix in a dust sufficiently well, or whether spraying with wettable powder or emulsion is more efficient.

Though efficient composting may greatly reduce or even eliminate Sciarids, a nucleus of eggs or larvae may sometimes escape destruction,

and it seems likely that infection might arise through eggs being laid in the cooler outer layers of the heap after the last turn. Spraying the heap at this stage with DDT or BHC may prove a useful measure.

Treatment of Beds before Casing

Where a good "peak heat" can be achieved after making the beds it offers perhaps the best occasion for dealing with pests that have survived the composting process. To what extent insects are killed by the heat depends of course on the temperature reached, but even when this is high (say 120° F. or more) some may escape, especially on the bottom beds which may not heat so well. However, the insects are forced to the surface by the heat and rendered highly active, so that they are vulnerable to attack. **It would seem that if an insecticide can be deposited just prior to peak heat there is the maximum prospect of obtaining good control.**

BHC, for the reasons already given, and because it kills other pests besides Sciarids, commends itself for this purpose. Although not subjected to scientific trial in this country, it has been used by growers for several years as "Gammexane Dust," at rates varying from 1 to 3½ lb. per 1,000 sq. ft., on the beds between spawning and casing, with no evidence of injury or tainting and no trouble from flies. It has been used at double the latter rate in experiments in Australia without damaging the crop. In Holland a 3% BHC dust used at 7 oz. per 1,000 sq. ft. once or twice a week gave complete control of Sciarids and caused no injury or taint. It is not known whether DDT or BHC smokes at this stage would leave adequate deposit; used in sufficient number they would in any case be rather expensive. The possibility of alternating BHC and DDT to reduce the chances of resistant races arising must not be overlooked.

Of other insecticides, nicotine, pyrethrum, HETP or TEPP are not persistent enough to be of the same value. The possibilities of Parathion are little explored, though being so dangerous to handle it will have to offer considerable advantages over BHC to be attractive. Other new insecticides such as chlordane and compounds related to DDT will have to be considered when they arrive. Fumigation with sulphur dioxide (burning sulphur at 1½-2 lb. per 1,000 cu. ft.) at peak heat is widely practised, and fumigation with cyanide (1 lb. of calcium cyanide per 1,000 cu. ft.) has been common in U.S.A. Neither of these gases penetrates the beds for more than an inch and having no persistent effect is unable to deal with insects escaping the initial exposure or subsequently hatching from eggs in the compost. They give only a moderate kill of most pests, especially insects on the bottom beds which often do not heat so well, and seem to have a value much inferior to that of BHC.

BHC exposed to peak heat conditions may break down more rapidly than at lower temperatures, and whether a further dusting before casing is desirable is another point to be investigated.

Treatment after Casing

Where for various reasons an attack by Sciarids occurs when the bed is cropping, control measures must chiefly be aimed at killing the flies to check further development of the infestation. For this purpose

DDT, BHC and pyrethrum are effective and claims have been made for HETP, though repeated trials to discover the optimum concentrations, formulation and method of application, with possible combinations of two of the insecticides, are necessary. DDT and BHC have the obvious advantage that being persistent they will kill not only flies present at the time, but those emerging subsequently. The length of this period of protection is unknown, though it would be expected to be two or three times the 10-14 days occurring out of doors, and will depend upon the nature of the deposit.

Smoke or aerosol would be the simplest method of application, though the deposits, at any rate from the smoke, are probably not equal in residual value to those from dust or spray. DDT is often used as a 5% or 10% dust or wettable powder made up as a spray containing 0.1% DDT. It is also available as an emulsion, and there is evidence that emulsions leave deposits of minute crystals several times as toxic as those from wettable powders, but there is little indication of their practical usage; the possibility of damage by the solvent itself, which would not dry off from a mushroom bed as rapidly as it does from foliage in the open, must be borne in mind. BHC is used as a dust or wettable powder (usually 3 lb. per 100 gallons). A "liquid" version, based on the gamma isomer of BHC, which makes an emulsion with water, is also available.

The larvae are more difficult to reach especially in the compost, though many in the casing soil are affected by sprays, or the washing in of dusts by watering, which has been found to bring larvae to the surface. It has already been said that DDT is not always effective against fly larvae, and BHC is likely to be more useful. Whatever insecticides are applied, any pickable mushrooms should first be cleared. Until more is known of the risk of contaminating the crop, it is advisable to minimise the use of DDT.

At one time there was a considerable scare concerning damage caused by DDT but the investigation by the Mushroom Growers' Association apparently failed to find any basis for it. The writer has also failed to get to the bottom of several cases brought to his notice.

It is possible that the carriers used in some cases have given trouble, and more likely combustion products from some of the earlier smoke generators. Preliminary experiments have suggested that there is little risk unless DDT is used in really excessive quantities. With BHC there have been no records of damage in this country. No injury has been reported with HETP or TEPP which have been used at rates varying from one to three parts in 1,000. However, especially with persistent chemicals which may build up in the beds, insecticides should be used as infrequently as possible until more is known of the safety margins.

It is hardly necessary to remark that "trashing" and destruction of discarded mushrooms and cut stalks is an essential part of general hygiene, to reduce to a minimum breeding places attractive to flies.

Whether a routine dusting of the beds after casing, probably with BHC, is desirable, needs investigation. Where mushrooms are grown

in glasshouses and Sciariids are likely to be among the natives, it is likely to be useful.

There remains the question of infestation of the beds from outside. The extent to which flies enter the building and the times when they are most likely to do so is not really known. Flies gleefully caught by growers at ventilators may have been on their way out, not in, for they are attracted by light, and may not in any case have been Sciariids. It is of course wisest to make the building reasonably insect tight, by screening ventilators and doors with strong gauze: 40 to the inch mesh should exclude Sciariids but not air currents.

The use of DDT or BHC to protect possible places of entry is claimed to be useful but the method needs investigation. With DDT it is questionable whether at the usual strength it will kill flies before they can lay eggs. Fundamental information on the concentration and formulation of sprays for this purpose which will achieve the desired result is still lacking. Such deposits might even deter flies from settling long enough to collect a lethal dose.

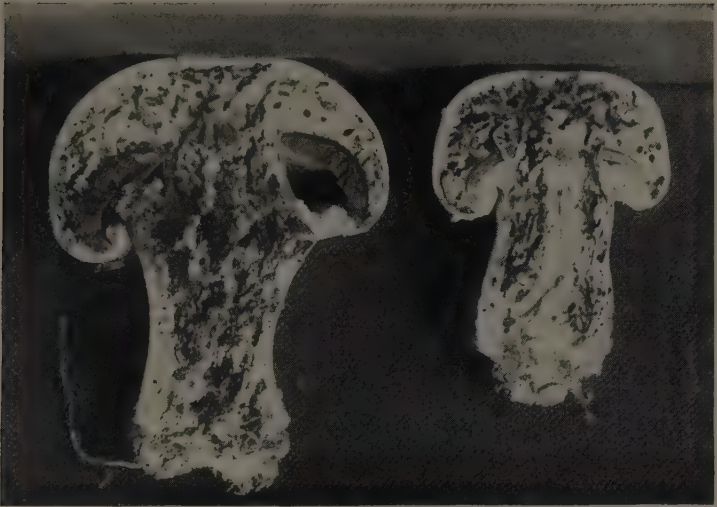
PHORID FLIES

These are also inhabitants of stable manure and their larvae attack mushrooms and mycelium, causing damage similar to that done by Sciariids. They are less common as pests, occurring chiefly in the summer months, but are capable of doing equally severe damage. So far only one species has been identified, *Aphiochaeta albidohalteris*, though no doubt there are others. Its life history has not been worked out. It is a small dark fly, with shorter wings than those of Sciariids, and its stouter body has a humped appearance. Its inconspicuous bristle-like antennae contrast with the prominent ones of the Sciariids. The larvae are distinguished from Sciariid by the absence of the black head case which gives them a headless appearance, and their white bodies are rather thicker.



PHORID FLY
Aphiochaeta sp.
(x 44)

Control measures successful against the other flies are likely to be adequate for Phorids.



CECID FLIES

Occasionally infestations occur of larvae of midges of the family Cecidomyiidae. The few published records suggest that the occurrences are usually in the winter months, but the writer has also seen them in the summer. Such outbreaks can be very devastating, but fortunately are not common.

The larvae are much smaller than those of Sciarids and Phorids, the slender body noticeably tapers towards both extremities, and the head is pale and so small that the larva appears to be headless. Two features serving to distinguish them from Phorid larvae can be seen with a hand lens: either, on some larvae, a dark brown spot (the "ocular spot") on the side of the body just behind the head, or in others a dark brown mark on the underside of the body just behind the head, shaped rather like an anchor with



MUSHROOM MIDGE (CECID FLY)
Heteropeza sp. (x 37)

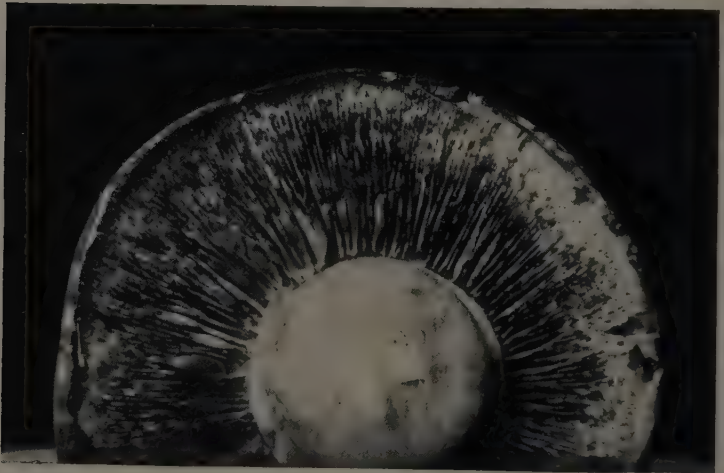
shortened arms (the " anchor process " or " breast-bone "). The body colour varies with different species from white to pale yellow or orange.

A remarkable characteristic of these larvae is their ability to reproduce paedogenetically, that is they can give birth to further larvae. This process can be continued over a long period so that tremendous infestations can build up in a few weeks ; sometimes the larvae, which appear to be brought to the surface by watering, can be seen in countless myriads on the casing soil, whence many fall to the floor and knot themselves literally into heaps like sawdust.

In accounts by Theobald and Barnes, relating to yellow larvae, infestations are described as associated with the failure of large areas of beds ; larvae were also found in large numbers among the gills, and burrowing in the caps, to which the damage was superficial and causing a stringy appearance. Browning and death of buttons and the disappearance of mycelium was attributed to their activities.

Cecid larvae are not easy to rear artificially, for they will go on multiplying for some time and then die. It is difficult to induce them to enter the chrysalis stage and produce adults. Consequently only on a few occasions has the identity of Cecids attacking mushrooms been established, the midges being *Mycophila speyeri* and a *Miaster* species. The summer infestation encountered consisted of white larvae which were successfully reared in laboratory mushroom cultures, and produced midges apparently of a new species.

These larvae were never found on the mushrooms themselves, but were present in countless numbers in the beds, both in compost and soil, where large areas had ceased to crop, the mycelium having disappeared. These areas were also wet, and as on the fringes the mycelium was brown and dying, it was thought that the excessive wetness may have



Gill Injury, possibly caused by Cecid larvae.

been the basic cause of the trouble. But when larvae were kept in mushroom cultures in the laboratory it was shown that they were associated with the disappearance of mycelium, though whether they had actually eaten it all was difficult to say. They were also associated with shrinkage of the compost, which became wetter than in the cultures without larvae.

Why the larvae swarm out of the beds after watering is not known. Indeed practically nothing is known about them : how long they can continue a paedogenetic life ; how long they can survive dryness ; whether they come in with the compost or subsequently ; what sort of natural habitats serve as the sources of infection ; and worst of all how to control them.

In experiments at Wye these larvae have remained alive a week after treatment with HETP (1 in 1,500), DDT wettable powder (0.1% DDT), DDT emulsion (1% DDT), 5% BHC dust, BHC emulsion (0.01% Gamma BHC), Pyrethrum powder and 5% Formalin. Sulphur dioxide fumigation was found by Theobald to be ineffective. The lowest strength of Formalin which can be relied upon to kill the larvae is 20% and this should be used to disinfest floors and walls when cleaning out a house, special attention being paid to cracks and spaces between joints in the structure. Since it would be necessary to wear a mask and protective clothing when applying Formalin at this strength, the potassium permanganate method suggests itself as more attractive, but no experiments have been made to discover its effectiveness against midge larvae. In this method the Formalin is placed in drums in the house, and potassium permanganate added at the rate of 1 lb. to 2½ pints of Formalin per 1,000 cu. ft. Formaldehyde gas is explosively emitted and nothing must impede the rapid exit of the operator.

On one farm, Cecid larvae persisted for over a year through three crops by hiding in cracks in the bedboards, despite creosoting of boards and use of a blow-lamp. Infested boards must evidently be submerged in creosote or formalin and heated to kill all larvae.

Occasionally mushrooms are observed in which the gills have a nibbled appearance ; they are shallow, with irregular, brown spotted edges, as though their growth had been arrested and marginal decay had set in. This " suppressed gill " condition is unexplained, but in some specimens examined Cecid larvae were found between the gills and also burrowing in the cap at the base of the gills, especially round the fringe of the cap. This was only discovered under the microscope, no sign of tunnelling being evident to the naked eye when the caps were cut open. The larvae may have been responsible for the condition by interrupting the food supply to the gills.

OTHER FLIES

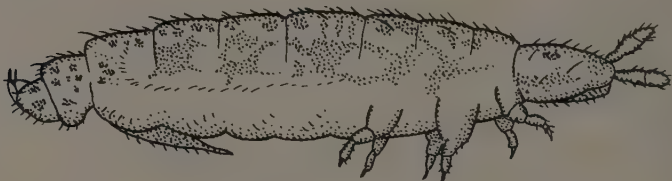
Various Drosophilid and Borborid flies have been bred from damaged mushrooms, but since Sciarids or Phorids were already present they were probably only secondary invaders. Borborids are common in manure and some species might conceivably act as pests.

SPRINGTAILS

Several species of springtails have been identified from mushroom beds, but most of the observations relate to *Hypogastrura armata* and its variety *inermis*. This is a minute creature about $\frac{1}{16}$ " long, varying in

colour from silvery grey to bluish black, and like the other members of its fraternity it has the power of jumping. It sometimes occurs in vast numbers, swarming on the beds and the mushrooms, often falling to the floor and forming living carpets; it is also liable to assemble in heaps, whence it has gained the name of "gunpowder mite."

When springtails feed upon mushrooms they excavate shallow pits in the stalk and cap edges, these pits being dry in contrast with the moist ones often associated with attacks by mites. Buttons may also be invaded, the interior of the stalk and cap being tunnelled in all



SPRINGTAIL ($\times 60$)
(From a drawing by J. Lubbock)

directions, the tunnels being dry and powdery and more regular than those caused by other pests. In severe cases the stalk may split. There is only slight discoloration, compared with the browning associated with mite injury. The points of entry can be seen as regular, oval, slightly sunken openings, generally in the stalk, often below soil level, though also on the cap.

A complete failure of a crop, through attack on the buttons, was attributed to springtails by Jary and Austin. In this case the mycelium was not destroyed, but in others attack on the mycelium has been recorded. The relative importance of springtails as pests is still rather obscure, for they are sometimes present without appearing to cause any injury. The compost and atmospheric conditions which render them liable to attain sufficient numbers and to become pests are not understood; in some cases they may not be primary parasites, only invading mushrooms already damaged or unhealthy.

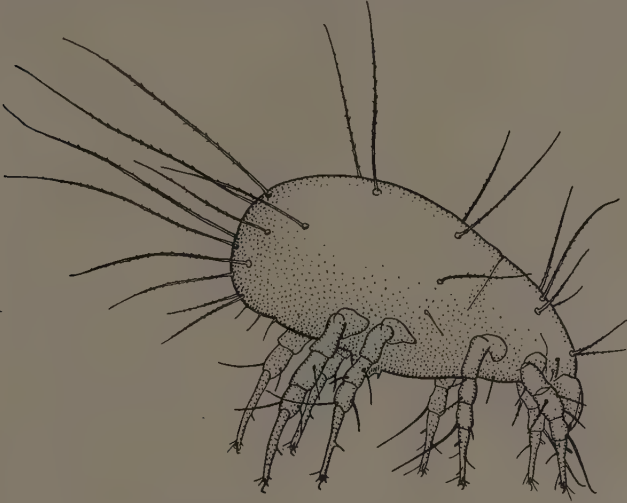
While springtails may already be present in glasshouses being used for mushroom growing, it is probable that they are generally brought in with imperfectly prepared compost. They are more readily killed by heat than the other pests, and are destroyed in the composting process if turning is efficient. Thomas in the U.S.A. states that they are killed at temperatures of 135-140° F. If they are present when the beds are being filled, some are liable to escape death at peak heat, especially on the bottom beds.

While, according to Thomas, springtails can be killed by fumigation with cyanide ($\frac{1}{2}$ lb. per 1,000 cu. ft.) at peak heat, BHC is very effective and used before casing as suggested for Sciarids should give good control. It can also be used in smoke or dust form while the beds are cropping. HETP or TEPP spray is also very effective, while DDT has been disappointing.

MITES

Of the various mushroom pests the mites are probably most in need of further investigation. Much of our information is due to S. G.

Jary, who in the course of his work contributed greatly towards clarifying the identity of the several species concerned.



Tyroglyphus dimidiatus ($\times 125$)



Left : Mushroom pitted by *Tyroglyphus dimidiatus*
Right : Mushroom damaged by *Ereynetes*

Mites are very common in organic debris, straw and fungi, though in mushroom beds they do not always attract attention owing to their small size, and in the case of some of the pests their sluggish movements, unless they are very numerous. Many species are predatory, feeding on other mites and small insects, while others subsist on straw and other constituents of the compost. The predatory mites of the family Gamasidae are whitish when young, shining yellowish or reddish brown when adult, and recognisable by the active way they run about the beds.

The mites attacking mushrooms are distributed in several families, the majority occurring in the family Tyroglyphidae. These mites are slow moving, and have soft, translucent, whitish bodies. They include *Tyroglyphus dimidiatus* (longior), which is by far the most important mite pest.

It is very hairy, some of the hairs being minutely feathery, and the posterior ones are almost as long as the body. It is found on cheese and other foods, straw, and occasionally attacks the foliage of cucumber and other glasshouse plants. It seems likely that it is most often introduced with the straw in the compost. In glasshouses it may already be present in debris. It is capable of excavating shallow irregular pits in the stalk and cap of mushrooms, the pits being moist and stained brown with excreta. The excavations may extend into the interior and buttons may become hollowed. It is possible that the mycelium may also be damaged, and that heavy infestations could cause a crop failure.

There are other members of the family which appear to be capable of causing similar damage, including species of *Eberhardia*, *Caloglyphus* and possibly *Rhizoglyphus*, but their identity is still somewhat uncertain, and precise information on their habits is consequently difficult to find, apart from the fact that little work has been done on this aspect. *Tyroglyphus mycophagus*, frequently referred to as a mushroom mite, is a name that has been given by different authors to several species of mite.

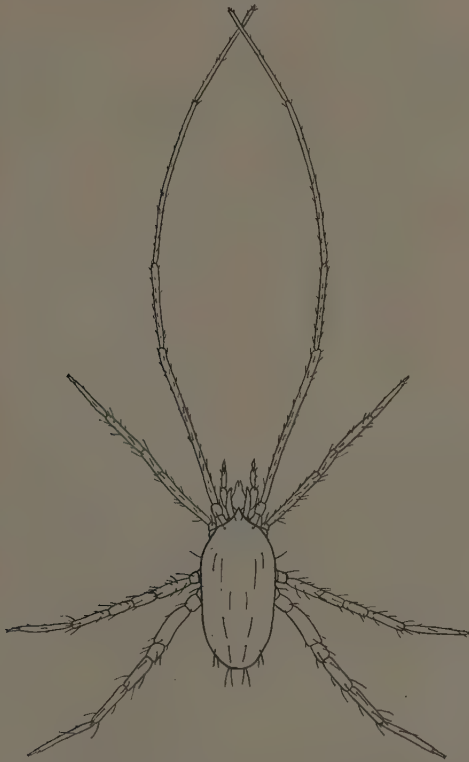
Tyroglyphid mites frequently assume a special stage in their development in which the body is of different shape, with reduced legs, and is supplied with numbers of suckers. This stage, known as the hypopus, can cling to any passing animal and thus be carried some distance ; on reaching a suitable medium it can transform to an adult mite and start a new colony. Mushroom beds may sometimes be infected in this manner, perhaps by the agency of flies. The hypopal stage has not been found in the case of *Tyroglyphus dimidiatus*.

Tyroglyphus farinae, the flour mite, has also been recorded from compost, but does not appear to attack mushrooms.

Histiostoma rostroserratum, which is found in fresh manure, occasionally occurs in the beds but only when the compost is over wet ; it is a very common mite in any wet decaying organic matter, and has not been observed to damage healthy mushrooms.

Small dark brown pits on the cap are sometimes attributed to Tyroglyphid mites, but the pits begin as points of decay below the skin, eventually opening to the exterior, and whether or not mites are

found in the opened cavities it does not seem that they can be the original cause.



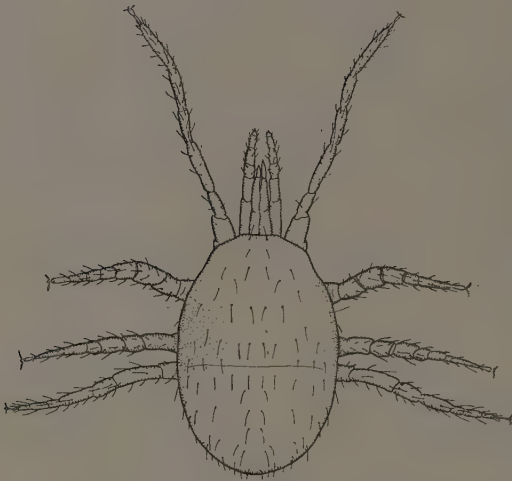
THE LONG-LEGGED MUSHROOM MITE

Linopodes antennae-pes (x 75)
(from a drawing by S. G. JARY)

The long-legged mushroom mite, *Linopodes antennae-pes*, family Eupodidae, is said to attack mushrooms both in this country and the U.S.A. Mycelium at the base of the mushroom is severed, growth is interrupted and the mushroom liable to topple over; the stem base has a characteristic reddish-brown discoloration, and is sometimes rather swollen. This fragile white mite is very active, and as it runs it waves its front legs, which are as long as the body, in front like a pair of antennae. It is not common and seems to occur in damp places, apparently being introduced with the straw. Belonging to a family of predatory mites it is strange that it should attack mushrooms; the evidence

that it is responsible for the damage described is only circumstantial. Another member of this family, *Ereynetes*, was found associated with similar damage at Wye, in 1949, and evidence suggesting that it was actually responsible for the injury was obtained in laboratory experiments.

Oppia nitens, a dark reddish-brown, hard-bodied mite, has occasionally been recorded as boring small galleries in stalk and cap, but is seldom numerous enough to be important. Nothing is known of its likely source.



Ereynetes MITE ($\times 180$)

mon with Sciarids and springtails, the mite numbers had fallen considerably after the final turn. Further, it has been claimed that where fresh manure is used, subjected to thorough composting so that every part at some time reaches a high temperature, trouble from mites seldom ensues.

However, mites seem less easily killed by heat than the other pests and it is possible that a few may survive to reach the beds. Also hypopal stages may be introduced by other insects. *T. dimidiatus* completes its cycle from egg to adult in 17-24 days, and in the laboratory the female lays 40-60 eggs, so that in favourable conditions a few mites could soon give rise to large infestations. Scrupulous hygiene in clearing out old beds and all debris is always important.

In laboratory experiments at Wye we have obtained over a 90% kill by spraying *T. dimidiatus* in mushroom cavities with a 3% liquid Gamma BHC preparation at 1 in 320. BHC 50% wettable powder at 3 lb. per 100 gallons sprayed on to beds gave good results against the same mite, and liquid Gamma BHC sprayed on another bed appeared to be very effective against *Ereynetes*. DDT emulsion at 0.1% (in this brand xylene was the solvent) gave equally good results against both species, both in laboratory tests and on beds. Azobenzene at 2 lb. 40% wettable powder per 100 gallons was disappointing.

It would seem that BHC dusts used on the beds before casing as for flies, especially if at peak heat, should help considerably in controlling mites. Where infestations of cropping beds have to be dealt with, BHC and DDT emulsion offer promise. One would expect spraying to be more effective in reaching mites in the casing soil and concealed among buttons than dusts or smokes. The maximum of insecticide which can safely be introduced, the possible effect of solvents where emulsions are used, the value of the residual deposits, are among points to be investigated. In the beds we sprayed, BHC, DDT

Sometimes very minute mites of the family Tarsonemidae, with narrower bodies than the Tyroglyphids, swarm on the caps like pepper dust. Under a lens they are seen to be running in a state of great activity, but so far no damage by them has been detected.

The control of mushroom mites is still a problem. During their study of the fauna of compost Austin and Jary noted that, in com-

and Azobenzene were applied at 1 gallon per square yard, in order to penetrate the soil as far as possible, but the beds had already become too poor to judge whether any harmful effects on growth occurred.

In Australia BHC dusts were stated to be effective against mites, but they were not species occurring in Britain. Where a dust with double the usual BHC content was applied at as much as 7 lb. per 1,000 sq. ft. (1 ounce per sq. yd.) there was no damage to the mycelium.

According to growers' reports HETP has given good results. Owing to its persistence Parathion cannot be used on cropping beds, but might find a place before casing.

MINOR PESTS

A few other pests remain to be mentioned. Millipedes, woodlice and slugs occasionally do damage, though usually only in outdoor beds or buildings adapted for mushroom growing, where they have sheltered in soil or debris or have access from outside.

Millipedes

Three species of millipede have been recorded, *Blaniulus guttulatus*, *Cylindroiulus britannicus* and *Choneiulus palmatus*, which by nibbling cavities in caps and stems and hollowing out buttons have at times caused severe damage.



Left: Mushroom damaged by mice.

Right: Mushroom damaged by slugs.

Woodlice

Woodlice will also eat into the caps. DDT and BHC dusts are effective against millipedes and partially so against woodlice. For the latter pest 3% gamma BHC solution at 1 part in 160 or HETP or TEPP at 1 part in 1,000 could give a higher kill.

Cavities eaten by *slugs* are identifiable by the presence of slime trails. Metaldehyde baits are the control for these pests.

Eelworms

Paine, in 1919, stated the eelworm *Rhabdites lambdiensis* could act as a carrier for *Pseudomonastolaasi* which causes "brown blotch" disease. This has not been shown to occur in Britain, but an allied eelworm, *Rhabdites teres*, has frequently been found in mushrooms exhibiting dark brown patches with underlying watery tissues, especially near the edges of the cap. Whether it is merely behaving as a saprophyte is not known.

In 1906, Newstead described a case in this country where total destruction of a crop was brought about by enormous numbers of eelworms occurring in the buttons and the mycelium. These eelworms were similar to *Ditylenchus (Anguillulina) dipsaci*, the stem eelworm which commonly attacks cereals, onions, clover, bulbs and many other crops.

In America a condition which was referred to as "*Cephalothecium* disease" has been known for 10 years and has assumed considerable importance in Pennsylvania. The mycelium disappears in patches, the compost sinks, decays and acquires a foetid odour, and a sparse mould growth spreads over the casing soil. Renewed investigation in 1949 suggested that the cause of the trouble was an undescribed eelworm closely allied to *Ditylenchus dipsaci*.

The eelworms puncture and feed upon the mycelium, and being capable of rapid growth soon spread in large numbers through the beds. The mould which develops on the surface has been identified as *Arthrobotrys superba*, a fungus parasitic on the eelworms. The worms are presumably introduced with the compost or soil, and since they are likely to be able to survive in dried material, very thorough cleaning out of infected houses is essential. Cases of *Ditylenchus* in mushroom beds in this country have so far been rare and not fully investigated. In one case the eelworms were identified by Goodey as *Ditylenchus intermedius*. It may be mentioned that the eelworms, which are transparent and thread-like, are little over a millimetre in length, and are unlikely to be seen without microscopical examination.

Research Fund S.O.S.

Over £900 still wanted

Despite two personal appeals, we are still barely two-thirds of the way towards our target of £2,500 to insure that mushroom research continues into 1951. Nevertheless, a slower response was not unexpected, for prices are now substantially lower than they were when we so enthusiastically "adopted" the Yaxley Station, 18 months ago.

Once again a firm of market salesmen heads the list of subscribers, and we say a very sincere Thank You to Messrs. Francis Nicholls Ltd., whose 100 guineas gave us so much encouragement in the rather depressing drafting of further begging letters. Major C. P. Whitaker,

	£	s.	d.		£	s.	d.
C/f. from Bulletin 19	817	0	0	Barracrough & Sons	5	0	0
Nicholls, Francis Ltd.	105	0	0	Cooper, N. R.	5	0	0
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Rooke, Dr. A. R.	10	0	0	Youngman, H.	2	0	0
Sunnyhurst Nurseries	10	0	0	Barton, Major J. H.	1	1	0
Sinden, Dr. J. W. (U.S.A.)	8	15	0	Cwynar, S.	1	1	0
Gammons, H. T.	8	8	0	Faulkner, H.	1	1	0
Coates, H. T.	8	0	0	Gale, J. B. & N. S.	1	1	0
Rice, Geo.	8	0	0	Hedley, Dr. E. P. (S.A.)	1	1	0
Shearway Nurseries	8	0	0	Warwick, R. G.	1	1	0
Thew, W.	8	0	0	Wellington Hill Nurseries	1	1	0
Millais, E. G.	7	10	0	Leach, T. T.	1	0	0
Appleyard, W.	6	0	0	Lichtarowicz, L.	1	0	0
Buckingham, R.	5	5	0	Martin, A. W.	1	0	0
Higgins, W.	5	5	0	Warner, F. F.	1	0	0
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Worthing, & W. Sussex N.F.U.	5	5	0				
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N.B.—10/- is received each month on a Banker's Order from Col. W. A. Turner.

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EXTRACTS FROM A MUSHROOM GROWER'S



DIARY



April 10. Those who have trays with the bottom slats placed ACROSS the box may still be able to use roller conveyors. It should be possible to make a simple lightweight cradle, several of them in fact, on which the trays could be placed. The cradle would obviously have, say, two slats at right angles to the rollers with a vertical "stop" at the front end. After so many trays plus cradles had passed over the conveyor the batch of cradles—collected at the receiving end—would be returned in one block to the filling end.

April 12. A friend has recently seen a play, entitled: "Cry Liberty," by Esther McCracken. I gather some part of the story is concerned with a nurseryman's comic, tragic, futile, frustrated attempts to obtain the necessary licences, permits, authorities, etc., to start a mushroom farm. I'm interested to know whether the subject has been dealt with as fully and forcibly as it might be!

April 20. Outdoor mushroom beds that should have started last December are just showing pinheads.

May 2. We have recently thought that attacks of cecid larvae were to be found only where poultry manure was added to the compost. A very careful check up shows that with one or two exceptions this has been so. But perhaps the exceptions are enough to discount the theory. At all events we go on using P.M. as required.

May 4. The Open Day has been an almost unqualified success. What an improvement on last year! To-day there has been something to see; something to eat, without disorganised to and fro-ing of bus journeys; plenty to drink for those who had time for it (the rush, crush, gossip and general button-holing effectively enforced my own total abstinence between the hours of breakfast—6 a.m.—and dinner at 7 p.m.); and undoubtedly a great deal to talk about. These fleeting opportunities of meeting old friends and discussing new problems are altogether welcome. Cannot we make it two days and so avoid those discursive, inconclusive conversations with which we are all too familiar? And whose brain conceived the Brains Trust—that novel conclusion to a Mushroom Growers' Day? I speak with feeling when I submit that it couldn't have been one of those taking part! I fear the organisers of this Day, who must be heartily congratulated on their splendid efforts, will feel hard put to it to make any major improvements next year.

May 5. Attended the first meeting of the International Conference. Regretted having to leave to-night. If only International Politics could be as hopeful, cordial, tolerant and co-operative as this Conference promises to be, how much better a world we should have. But here all are working to one common end—maybe that's the explanation. I

do wonder, however, how the language difficulties will be overcome as the week goes on. Already I notice the "Champignon/Mushroom" interpretation is being conveyed by means of hand signs and sundry gyratory movements in the International atmosphere!

May 6. What a happy thought that publication of Mr. Atkins's book should coincide with the Open Day. Simultaneous events of first importance! Though no lover of textbooks—as the world knows—I must confess F.C.A. seems to have produced a most comprehensive survey of Mushroom Growing To-day. The contents are most expectedly up-to-date. If no particular aspect of cultivation (in that section of the book) is treated down to its last minute detail, it is only because to do so would require a book of this or greater length for each subject, and even then only one grower's views would have been given. For the author has been careful to avoid dogmatising from the one-grower angle. What he has done is to collect, collate and arrange for us in the most readable and attractive form all the available practical (and to some extent scientific) information up to the end of 1949, with the result that this book is a complete manual of Mushroom Growing for 1950 for the professional and amateur alike. As time produces more information we hope Mr. Atkins will make an excursion into the realms of the more obscure details of cultivation and as surely and wisely co-ordinate them for our pleasure and use as he has now done with present knowledge. At any rate he assures me he remains, *ours truly*,
Fred. C. Atkins.

May 10. I understand the continental scientists and growers who came over for the International Conference were surprised at the amount of spawn growth we get up into our soil in England. Soils vary, of course; some seem to need a full growth while others are content to have it only in the bottom layer near the compost. It is, perhaps, a matter of air. An airless (by comparison) casing might need the growth to the surface—where it can get air. On the other hand an open, lumpy casing permits air nearly down to the compost and presumably fruiting can take place there because the air is there. No doubt it is also connected with atmospheric humidity—which can of course reach the same point as air. I don't think there are any clear proofs that one condition will necessarily produce any better than the other, provided each soil receives its correct treatment. I expect I shall be shot to pieces, but . . . well show me the proof!

May 12. I am repeatedly amused at the trouble taken over *cures* for mycogone. The latest is Dithane Z-78, commonly (?) known as Parzate. Yet the simplest guarantee of freedom is efficient steam sterilisation.

May 14. A customer swears that cultivated outdoor mushrooms taste better than the indoor grown. He may be right. We know browns taste better than whites. Yet the public prefer whites, and the customer (which one?) is always right.

May 20. I hear that two well-known Worthing growers get mycogone despite sterilisation of soil. Yet I don't withdraw what I wrote earlier. I suggest (a) sterilisation is not complete if done by steam, and baking

is a bad method anyway, and (b) if sterilisation by steam IS complete there is re-infection from some other part of the plant. O.K. Worthing, shoot again!

May 25. Most interesting. A casing of sandy loam mixed with clay loam was doing badly—about 0.4 in 3 weeks. So we mixed with an experimental section a half-inch layer of discarded leaf-mould/peat/sand potting compost from the nursery, loosening up the original casing, working in the added layer and leaving untamped. The result has been staggering. Three flushes so far :—First 0.3, second 0.77 and third 1.0 lb. per sq. ft. Never have I had 1 lb. in one flush before. The rest of the house is now at the 1.4 mark and looks finished. This experimental section looks like going on to a good fourth flush. But what is the cause? Is it pH? The original casing was very high and the added potting compost very low. Have we produced a proper pH balance? Or is it air—loosening up the clay content? We are experimenting further in the same house to sort out those questions.

May 26. A new composting method has possibilities. 1 lb. in 14 days, 1.25 in 17. Yet there's a snag. The same method in another case is producing very slowly. Which is the freak?

May 27. I am told my figure of 1 lb. per sq. ft. in one flush will not be believed. Gentlemen! Gentlemen! Any statement appearing in this impeccable Diary not commencing with such phrases as "It may be It could be Perhaps It would seem It would appear" (the last two beloved of scientists!) is founded on truth as far as I know it. That means that in giving figures careful checking is done by me personally before anything gets by. If I say I have done 1 lb. in one flush, you may be sure I have done it. Q.E.D.

May 31. For my sins and for bragging too much about the easy way to prevent mycogone I am now under a cloud of Mycogone rosea. Not, mark you, perniciosa. I take some comfort in the fact that according to our new Atkins manual *M. rosea* is a "rare disease." The same work informs me that prevention is the same as for perniciosa. The source in my case is the leaf-mould potting compost mentioned earlier which was NOT steam (or any other) sterilised.

June 1. It's a pity *Arthrobotrys* does not appear BEFORE eelworms. It might then start "trapping" them before they did harm. That's how I feel to-day—another two attacks are reported. Both are in the same houses as the last round: both have started on the bottom beds. Theory: they have remained in the timbers and have not been killed off during heat-up which probably did not reach a high enough temperature on the bottom beds, though 125° F. was attained on the shelf above. Moral? Steam the boards and/or use fans during the heat-up.

Harold Quirk

Fred. C. Atkins Thinking It Over

“ TRASHING ”

The advent of the Tray System, with its shorter cropping period, has brought with it a revival of interest in an old problem.

When a bed has been picked over, one grower will go round again removing “ roots,” cores of matted mycelium and dead buttons the same day. Another grower will trash between flushes only. A third will trash every two or three flushes. Recently I saw a grower on the 30-days-crop system in trays who was not picking his mushrooms but cutting them off, and doing no cleaning at all. Now who is right?

There is not much laughter to be heard among horticulturists nowadays, and it was cheering to find young Mr. Orritt hitting out at others less “ progressive ” than himself and somewhat hesitant over the Tray System. But perhaps he will forgive me if I consider this trashing question first from the shelf grower’s angle—from the angle of the Old Method, as he dubs it. I have seen a great many mushroom farms in recent years, and my conclusion is that **careful** trashing after every heavy picking and between each flush is worthwhile.

Personally, I would prefer to trash immediately after **every** picking. Not only are “ cores ” sought by flies, who like to lay their eggs on them, but while they remain in the bed they prevent any further mushrooms from appearing in just that spot.

The principal argument against frequent trashing is that it cannot be done without disturbing the area immediately around the core. In reply to this I suggest that a skilled “ cleaner ” with a sharp, pointed knife can wheedle out cores with remarkable facility—the degree of disturbance being determined by the size of the core.

I hasten to forestall dissentients by admitting that with certain fine soils the mycelium knits the particles so closely that trashing often kills off a number of neighbouring buttons. This is one of a dozen problems associated with powdery soils, and it is not surprising that lumpy casing is preferred by many growers nowadays.

But beds cased with any type of soil seem to benefit from the comparatively drastic aeration inseparable from the act of trashing, and the demise of those poor little buttons is not a high price to pay for getting air to the bed. Many times have I seen superb spawn runs stifled by an almost impermeable inch of dust.

With the Tray System, of course, the problem of trashing is rather different. I have heard that, when the trays are cropped for only 30 days, no attention is paid to the cleaning of beds. This is understandable, for careless trashing may well mean the missing of the next flush, and perhaps it is best to leave the beds alone. It certainly saves much labour.

But when the trays are cropped for seven or eight weeks—which is done, even on the five-crops-in-a-year cycle—thorough trashing after every flush except perhaps the last is surely advisable. Apart from the factors already touched upon, it seems easier to miss spots of trouble in the shadows of a growing room closely stacked with trays—and a careful routine check-up between flushes would be time gainfully spent. A single mushroom spotted with *Verticillium*, for example, could well infect the entire house if neglected.

1950 OPEN DAY

International Brains Trust

OVER 500 VISITORS

"HIGHEST CONGRATULATIONS ON THE LATEST CLIMAX OF THE M.G.A./M.R.A. WORK. THURSDAY, 4th MAY, 1950, WILL SURELY BE A RED-LETTER DAY IN THE MEMORY OF THOSE WHOSE EFFORTS HAVE BEEN DIRECTED TOWARDS CO-OPERATION WITHIN THE INDUSTRY. HOW WILL IT BE POSSIBLE TO DO BETTER NEXT YEAR? ONLY MINOR DETAILS COULD BE IMPROVED."

So runs a letter typical of many which poured into Yaxley during the weeks following the Research Open Day and Trade Show. It is conservatively estimated that over 500 growers and others connected with the Mushroom Industry were present—and the village of Yaxley has probably never seen so many cars in so small an area from so far afield—apart from Britain, there were representatives from the United States, France, Holland, Belgium, Sweden, Denmark and Switzerland.

Despite the fact that one-third of the visitors had not reserved lunch tickets, Mr. and Mrs. Lawrence Barker, of Peterborough, catered for all with a pleasant meal of hot soup, ham, tongue and beef salad, trifle, and cheese, while Mr. and Mrs. F. Clark, of the Norman Cross Hotel, received many compliments on their fully-licensed and well-patronised bar. The weak points were the car-parking and sanitary arrangements—but Secretary Watson has noted them, and we can rely on him to overcome these difficulties next year.

Visitors began arriving at 9 a.m., and by 10 o'clock, despite cool weather and an occasional drizzle of rain, success was assured. What particularly struck so many of us was the atmosphere of friendliness which was so manifest. Experienced exhibitors say they have never experienced such goodwill as was to be found in the competitive Trade Marquee, where 20 specialist firms and sundriesmen had staged a most interesting display of practically every article of interest to the commercial mushroom grower.

The exhibitors were the **Hampshire Guano Co.** (poultry and other guanos), **D. C. Bushell & Co. Ltd.** (long-straw horse-manure), the **Hymatic Engineering Co. Ltd.**, and their area agents, **General Factors (Eastern Counties) Ltd.** (mobile compressor sets, trigger and quick-action lances, nozzles for insecticides, creosote and limewash spraying, spray guns for painting, for atomization of insecticides, powder dusters and air hammers), **Bee Rite Boxes Ltd.** (mushroom trays, horticultural trays, moisture meters), **Pan Britannica Industries Ltd.** (complete range of sterilizing fluids: insecticides and fungicides as used in mushroom cultivation, charts giving details of the various pests and diseases and their recommended treatment), **British Basket & Besto Co. Ltd.** (a full range of non-returnable veneer packages and covers from $\frac{1}{4}$ lb. punnets to 12 lb. baskets, with special reference to mushroom baskets, potatoes chitting trays and orchard boxes made from sawn timber),

ND TRADE SHOW

Bradford Fertilizer Co. Ltd. (samples of M.R.A. synthetic compost and their own organic fertilizers and activators, their own production of dried blood and soluble blood), **Harry F. Atkins (Machine Tools) Ltd.** (DLP compost turner, fitted with powder sprinkler and water sprinkler, soil breaker, trigger-controlled handspray), **E. J. Hibbins** (electrical equipment for use on mushroom farms), **Pinkerton's Scottish Mushroom Laboratories** (spawn and details of their advisory service for mushroom growers), **Mono Pumps Ltd.** (portable Mono pump for spraying disinfectants and insecticides, Mono pump for handling clean water), **British Rototherm Co. Ltd.** (mushroom, silage and general thermometers), **Rural Electrification Services Ltd.** (two electric soil sterilizers, 2 cwt. and 5 cwt. sizes), **Thomas Elliott Ltd.** (comprehensive range of fertilizers, including M.R.A. synthetic compost activators "A" and "C"), **Geo. Monro Ltd.** (outline of the complete service they offer to mushroom growers from the supply of spawn through to their marketing facilities), **W. Stevens** (literature and photographs referring to mushroom cultivation), **F. Gough & Sons Ltd.** (full range of mushroom baskets), **West Dock Timber Co. Ltd.** (proto-type mushroom trays), **Murphy Chemical Co. Ltd.** (wide range of fungicides and insecticides), **Atlas Basket Co. Ltd.** (2 lb., 4 lb., 6 lb., extra super 6 and 12 lb. metal handle chip baskets and cardboard covers, $\frac{1}{4}$ lb., $\frac{1}{2}$ lb., and 1 lb. square punnets), **Celcure Ltd.** (Celcure treated timber, including treated mushroom trays, bedboards, seedling boxes, Dutch lights, and other articles which may be of interest to mushroom growers). Mr. Hibbins generously wired the marquee free of charge for those requiring electricity.

There was a joint M.G.A./M.R.A. Information Stand, staffed alternately by Mr. Watson and Mrs. M. Crowson (Dr. Edwards' Private Secretary), and a selection of mushroom literature was on view which had a ready sale.



An International Joke is made by General Sir Oliver Leese (left) with Dr. E. B. Lambert (U.S.A.), Mr. J. P. H. Woltman (Holland) and Mr. P. Guiochon (President, French M.G.A.)

(PHOTOGRAPH: Peterborough Citizen & Advertiser)

But the primary purpose of the Open Day was to show the Mushroom Industry what the Research Station was doing. In the laboratory were to be seen some brilliantly-designed and executed wall charts demonstrating the life cycle of Truffle, the proper use of superphosphate in synthetic compost, the effect of the period of composting, the value of "trace elements," and the importance of the time when beds were cased. In the Composting Shed the Calor Gas peak-heating plant was on view.

In attendance with Dr. R. L. Edwards (Director of Research) to answer questions were all the members of the M.R.A. Staff: Mr. S. Burrows (chemist), Miss C. W. H. Duncan (microbiologist), Mr. G. R. Brown (grower) and his assistant (Mrs. Reeves), and Miss I. Warman and Miss M. Yarrow (laboratory assistants).

Experiments in progress were concerned with the fortifying of long-straw stable manure, the length of the composting period and the possible advantages of peak-heating. The trials in the experimental houses were numbered, but it was too early to give any results, as had been hoped.

Not wishing to cause despondency the M.R.A. Directors did not stress too strongly the urgent need for more money to enable the Station to carry on. But to quote *The Fruit Grower* (11.5.50): "Yaxley's research programme, from the very nature of the work undertaken, calls for simultaneous work on the chemical and microbiology sides. It is essential that these departments progress hand-in-hand. Unless the necessary



In the laboratory—DR. H. C. BELS-KONING (Holland), on right, is asked a leading question by DR. I. F. STOREY (N.A.A.S. Mycologist, Leeds), on left. Behind is MR. S. BURROWS (M.R.A. Chemist), and with his back to the camera MR. P. H. WILLIAMS (Cheshunt Mycologist).

money is forthcoming—and it must be remembered that the Ministry's support is only on a pound for pound basis—there will be no alternative but to curtail the work of one of these departments. Growers have a right to a living—so have scientists; the Station's chief outgoings are wages for its small yet highly specialised scientific staff. And, since even science cannot go on without bread and butter, if salaries cannot be forthcoming, part of the work must stop. Visiting growers can have been left in no doubt as to the importance of the work going on."

On the nearby farm of Noble Mushrooms Ltd.—which was seen by most of the visitors, conducted in relays by Mr. B. A. Noble (Managing Director) and Mr. W. H. Austin—interest was divided between the new DLP Composter which was in operation and the first full-scale test on that farm of the latest M.R.A. formula for synthetic compost. **Not only had it come into crop 44 days after the beds were made—compared with the customary 56 days—but it had so far yielded 3 lb. per sq. ft. in 8 weeks' picking.**

Altogether, then, there was much to make this Second Annual Open Day memorable. It was, to quote *The Grower* report (13.5.50), "probably the only event of its kind in the world; certainly there is nothing like it on the Continent or in the United States."

But more was to come. At 3.30 p.m., in the second marquee, a Mushroom Brains Trust, with an international flavour, was held under Question-Master Arthur Hovell, Chairman of the M.G.A. The brains were three scientists renowned the world over: Dr. Edmund B. Lambert, Director of Mushroom Research in the United States and Life Honorary Member of the M.G.A.; Dr. P. J. Bels, Mushroom Advisor and Research Scientist for the Netherlands Government; and Dr. R. L. Edwards, Director of Mushroom Research at Yaxley; and three of our leading growers: Capt. G. P. Lawrence (Andover, Hants.), Mr. Stanley Middlebrook (Braydon, Yorks.) and Mr. Fred. C. Atkins (Yaxley). Mr. Hovell's amiable generalship added much to the enjoyment of the occasion, and the 90 minutes passed only too quickly.



MUSHROOM BRAINS TRUST

Question 1. Would the Brains Trust agree that a 6 sq. ft. tray, in hard wood, is the most economical, as this size represents the maximum loaded unit of weight which two men can comfortably handle?

Lawrence: I myself am using trays 3 ft. \times 2 ft. I do not want them any bigger.

Middlebrook: An important point with the Tray System is to have the bottom timbers of the boxes built in the length of the box and not across the box because, inevitably, if we go in for the system thoroughly and completely we shall have to resort to conveyor rollers or belts,

If rollers, and the timbers are laid across the tray, it will not roll.

Lambert : In one of the large Tray System plants in Pennsylvania the trays are about 7 sq. ft.

Question 2. In order to gain even more advantage of tray culture and to maintain strict continual use of the growing room, could not the propagating period in the heat room be prolonged to the pinhead stage?

Middlebrook : You require the propagating room for propagating at a high temperature. After casing the beds you need more ventilation, and the trays would have to be set up checker-wise.

Edwards : Another point is that if you handle the trays once to case them in the propagating room you will have to handle them again when you move them into the growing room.

Atkins : I feel there is a great deal of muddled thinking about the Tray System. One normally has one heat room to feed three growing rooms. You have three growing rooms producing four crops a year, which means a total 12 crops a year. If you were to have no heat room, and used all four houses as growing rooms, you would get only three crops a year from each, which again is 12 crops a year—with less handling. The real advantage in having the Two-Zone System is that only the heat room need have steam plant laid on.

Question 3. In view of the recent introduction of British-made granular spawn, the average grower is unable to maintain ideal humidity for the surface running of grain spawn in a shelf house. Would it be sufficient to rough the grain into the bed-surface lightly by hand in order to give the grain a covering of compost?

Lambert : Grain spawn is used in America by about one-third of the growers, and they usually rough it in and close up the house pretty well during the first few days of growing the spawn. It will be perhaps half an inch under the surface in a week or 10 days.

Question 4. What is the minimum number of days in which composting can be carried out satisfactorily?

Middlebrook : I have found it possible to grow $2\frac{1}{2}$ lb. to the sq. ft. with seven days composting, but we have not a lot of information about this. Some interesting charts may be seen in the laboratory. There does not appear to be any advantage in composting longer than two weeks, but it all depends entirely on the shape, density and moisture of the compost pile.

Lambert : We compost both outdoors and indoors. We consider it an integrated progress—composting outdoors and pasteurizing in the bed. If you put manure in the bed immediately, without any outdoor composting, you can do a fairly satisfactory job in about two weeks. We compare two days outdoors with one day inside. We have people who compost for 35 days and people who compost for three or four days. One large grower using shelf beds in Chicago grows about half-a-million sq. ft. a year; he composts four days, turning every day, puts it in the house and pasteurizes eight to ten days. With Dr. Sinden's system, he has compost outdoors for about two weeks, and then pasteurizes a shorter time in the house. He tells me he likes to compost ten days.

Edwards : Our experiments with synthetic composts show that composting time can be very much cut down, always provided that you

are quite sure of a good peak heat afterwards. In our case, three days peak heating made as much change in the compost as three to four weeks outside. The proportion was much greater than in Lambert's, but we were dealing with different material. It is certain that composting time can be cut down if you can follow it by a satisfactory peak heat.

Question 5. What is considered to be the most economic period to leave a house cropping, and how soon should it be emptied in order to produce the maximum yield in a year?

Atkins : It depends entirely on the rate of production and the intervals between the various stages of production. At Noble Mushrooms Ltd. we attempt to follow a schedule on these lines : one week between emptying a house and filling it again—eight weeks from filling to coming into crop—eleven weeks picking. That is a 20-week cycle, giving us $2\frac{1}{2}$ crops a year. But this depends on your production curve and how soon it falls away. We hope soon to publish a note on a simple graph to calculate the optimum picking period which was devised by my brother John.

Edwards : The best cropping time depends on the kind of manure you are using and on the depth of your bed. Manure which is short of nitrogen or has too much straw in it will not keep cropping so long as a rich manure. Deep beds will keep cropping efficiently longer than shallow ones.

Question 6. What is the optimum humidity in the growing quarters?

Bels : I think the optimum humidity in the air must be about 80%. It is very important that this humidity is not derived from the beds (the compost, the casing soil or the mushrooms themselves); when you get this, you will get mushrooms opening quickly. You must maintain your humidity at 80% by spraying the floor, ceiling and walls; it will give you much better quality.

Question 7. Do you consider that watering between casing and the pinhead stage is harmful?

Atkins : Not if the casing soil requires water!

Middlebrook : A lot depends on what you propose to do with your casing soil once you put it on. If you want to produce stroma you do not water the soil—or you would kill off the mycelium trying to creep through to the top. Most growers prefer to grow without stroma, which means that they must have water on at some stage or the beds will dry out. It depends on how much water you put on the beds and whether or not there is any ventilation in the house.

Lambert : Most of our growers prefer to put on a damp soil, not water.

Question 8. Do you consider that chogging the beds is necessary with trays?

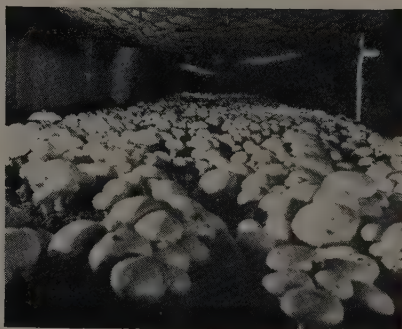
Middlebrook : I have heard of one grower growing 3 lb. per sq. ft. without chogging.

Edwards : I have seen trays growing which have not been chogged and they had the most wonderful collection of moulds growing on the stems that I have ever seen on a mushroom bed. They may have been quite harmless, but I should feel happier if they were not there.

Atkins : Doesn't it depend on your particular system of growing

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in trays? If you are cropping for only 30 days it is probably not necessary to chog the beds —or clean, or trash, or core them. But if I cropped for 9 or 10 weeks I would most certainly trash.

Question 9. When picking the first flush on a new bed I have noticed in the soil, under clumps or under single mushrooms, a sort of white plaster built up from mycelium. Should it be removed?

Atkins : If it is matted mycelium you must take it out. You won't get mushrooms growing through it. Even if you lose some of the mushrooms growing immediately adjacent to it, you will find the bed appreciates a fresh dose of soil. You will minimise the damage by removing the core with a sharp knife.

Middlebrook : We have had instances where a second flush pushed through the soil before the first could be cleared, and many of these second-flush mushrooms came around the base of the first-flush clumps. Trashing would have lost half-a-pound to the square foot in these areas.

Lawrence : I agree. After the first flush we do not cut out any stumps. We find a lot of mushrooms growing so close that we would inevitably have removed them had we trashed. Anything looking brown and nasty goes, of course, but the less I take out the better I am pleased.

Question 10. What pest and diseases (a) cause most loss to growers, and (b) are most difficult to control on a commercial scale?

Lawrence : I should say it is a yellow mould growing between the compost and the casing soil in one of my houses.

Middlebrook : My choice is truffle and eelworm.

Atkins : Truffle and Cecid larvae.

Bels : In the caves in Holland and Belgium, *Verticillium*.

Question 11. We have all heard about keeping beds clean, removing infected mushrooms at once, and so on. Do any growers apply these measures strictly, and do they give effective control over Verticillium and Bubble?

Atkins : Yes (laughter).

Lambert : We feel that after Bubbles and *Verticillium* make a certain amount of headway, any cleaning of the beds does not help. We give up (laughter).

Question 12. Is heavy-transport manure worth more than racing-stable manure, and if so, by how much per ton?

Edwards : Not having to use any of them and, more important, not having to pay for any of them, I can say quite happily that I think heavy manure has to produce half-a-pound per sq. ft. more than racing stable manure to pay its way.

Lambert : I suppose we do as you do ; when we have racing and other types of manure available we blend them.

Question 13. Why is it that, given exactly similar conditions of temperature and humidity, flushes of mushrooms will come alternately large and small?

Lambert : We have large and we have small mushrooms, and we have no control over it whatever (laughter).

Edwards : We are in the same position exactly. I would add that although I have often seen a flush of a large number of very small mushrooms alongside a small number of large mushrooms on the same

bed, I have not seen them come regularly in alternate flushes. The question should rather be : why do we get in some flushes a large number of mushrooms and in other flushes a small number?—for that, in my opinion, is the reason for the difference in size.

Atkins : I cannot explain it, but a heavy flush is sometimes followed by a light flush, as if the bed were temporarily exhausted ; but the succeeding crop is usually normal.

Middlebrook : I cannot agree that large and small mushrooms alternate with every flush.

Question 14. All my houses flush at the same time : consequently I have plenty of mushrooms one week and hardly any the next. Is there any way of holding back a flush in some houses so as to obtain a more continuous supply ?

Edwards : I would put up with a great deal of hardship rather than do anything to stop mushrooms growing. I have been asked to stop them growing on Sundays and Bank Holidays (laughter), but I cannot do that—it might be very dangerous to try.

Middlebrook : It is very dangerous. I tried one Christmas, by cooling off a house a week beforehand. It was producing very well up to that point, but never produced any more even though I put up the heat again.

Lawrence : I try to cool off about Christmas-time and, as far as I can see, it has never done any harm at all.

Question 15. It has been suggested that 2 inch wire mesh would make a satisfactory material for trays : is this so ?

Lambert : I never use wire mesh.

Atkins : I think it would be all right, but you would have to lay stout paper or something else on top of it, and that can be surprisingly expensive. Wire mesh must be galvanised, and although it lightens the tray it increases the price.

Middlebrook : One advantage is that you often get as many mushrooms below as on top (laughter).

Question 16. Is it an advantage to put manure through a composting machine with the object of breaking up the straw, as against hand-turning where the straw remains in longer lengths ?

Middlebrook : The question suggests that the machine breaks up the straw more than hand-forking does, and I don't know whether that is quite true. The whole point of the composting machine is that it does the job better than it can be done by hand. I don't think it breaks up the straw more, but it aerates it better, which is more important. It certainly cuts down labour. When I say better than by hand I am not disparaging the ordinary workman, but it stands to reason that by about 3 p.m. we get frightfully tired. The machine does not get tired like that.

Edwards : It all depends whether you have to shake manure yourself ; if you do, the machine is a decided advantage. As to whether the machine breaks the straw or not, we have results, I think, that show the straw at the end of the process is more broken after the machine has been used than if it had been turned by hand.

Middlebrook : Can I never say anything right ? (laughter).



Left top : Mr. B. Inachin (centre) and Mr. E. Buttikofer (right) examine the new DLP Composter shown by Mr. John Atkins (left).

Left Bottom : Brig. J. S. Nicholls asks some questions about the Mono pumps displayed.

Right Top : A group of growers listens to an explanation given by Mr. B. A. Noble (extreme right)

Right Centre : Mr. H. Kilian and Mr. Saltmarsh discuss Grain Spawn with Mr. John Smith (Pinkertons)

Right Bottom : A party visiting Noble Mushrooms Ltd. file into the Composting Shed. The Noble Drip System is seen at right foreground.

Lambert : Most American growers are convinced that they would rather use a turning machine than turn by hand, because they all use turning machines. Their machines are a little different in that they elevate the manure and the roller breaks it and throws it on the heap so there is no more handling.

Question 17. What proportion of growers in the countries represented on the Brains Trust now grow in trays?

Bels : There is now one on a big scale in Holland, and two on a small scale. I do not think there are any in Belgium. As far as I know there are none in Sweden, but perhaps there are some in Denmark. I have not visited France. (A voice : In France, yes.)

Edwards : In Great Britain I should say not more than 5 per cent.

Lambert : In America 2 per cent. or less, but some of them are rather large growers and would represent a higher percentage in square feet.

Question 18. Is the bogey of "site contamination" any nearer solution?

Middlebrook : I would say there is no such thing as site contamination at all, except where beds are grown on the ground.

Atkins : I agree with Middlebrook—and I think that should go on record! (laughter.) As with all bogeys, if you face up to site contamination you find that it does not—or need not—exist. If you grow on the ground you must sterilize your ground area. In shelf cultivation, if you follow the normal routine of cleanliness, sterilizing between crops, you should never get any build-up of disease.

Bels : I am not quite sure whether site contamination exists.

Edwards : I agree with Atkins and Middlebrook. A lot of farms have grown on shelves, using the same timber and the same buildings for quite long periods with no evidence at all of the steady fall in crops which it is alleged is site contamination. Where there is such a fall, even then you cannot pin it down to successive attacks of one disease. I think that in such cases it is a general contamination with diseases which is mainly responsible.

Lambert : What I would interpret as site contamination is the re-appearance of poor crops on a particular place in the bed from year to year. This happens in many houses in America, and recently, where we have had one end of a bed yield poorly, it has been traced to trouble which shows up in the manure by the disappearance of the spawn after the second or third flush. These beds are usually the lower beds.

Question 19. Can mushrooms be successfully grown in buildings where there is no artificial heat?

Edwards : Yes.

Bels : I agree.

Atkins : What is meant by "successfully"? You can get decent healthy crops now and again, but you have no control over them.

Question 20. What does the Brains Trust suggest will prevent or control Corticium?

Atkins : One of our constant irritations is *Corticium centrifugum*. We gave a photograph in a recent Bulletin. It is a white mould, rather similar to White Plaster Mould only rather finer, and it does not turn

the same pink colour. We do not know the control for it ; we would like to !

Question 21. What is the best type of preservative for timber used in beds or trays in mushroom houses ?

Lambert : Large tray growers in America use Cuprinol (copper naphthenate).

Edwards : Yes, one or other of the proprietary wood-preservatives, or good-quality creosote will preserve boards satisfactorily. It is important that it should be good creosote, because several people recently have had serious trouble which they attributed to creosote.

Middlebrook : It might help if someone told us what is the right type of creosote. Several growers have suffered very badly from the use of creosote, while others are getting normal results.

Atkins : I was advised to ask for " B.S. 144 high-temperature distillation creosote," and the reply was " What the hell's that?" (laughter).

Edwards : Creosote is made by several processes, and before the war there was a good supply of good-quality high-temperature creosote. That is covered by British Standard Specification 144 to which Atkins referred. But it does not mean that creosote outside that specification is necessarily harmful. I think you should ask for high-temperature distilled creosote ; that should be all right, but supplies are scarce and, if you cannot get it, it may still be possible to get good creosote.

Question 22. Some growers have had trouble with creosote : what is the best method of getting rid of it ?

Edwards : I have heard of several cases where boards have been " flamed " with a flame gun, well scorched, with satisfactory results. I cannot vouch for that.

Question Master : We have had the same trouble with seed trays in the nurseries, and we found the best way to get the creosote out was to scorch it out.

Question 23. Does the casing soil supply any nutriment to mushrooms growing in it ?

Bels : As far as we know, casing soil has no nutrition value.

Edwards : I would not say definitely that it has not in any case, but I am quite strongly of the opinion that it need not have any. A completely inert material can be satisfactory for casing.

Lambert : I quite agree with Edwards.

Question 24. Could " turning " be eliminated by loading beds with raw manure and peak heating for a long period ?

Lambert : You can do that, but I would not advise it commercially. You would have too much trouble in controlling moisture in the manure. You would have to turn it outside to get the moisture correct before you put it in.

Question 25. Does the artificial heating of the bed with a soil-warming apparatus during cropping increase the yield ?

Bels : We have visited many growers in Switzerland and I think it very useful to have the temperature of the beds some degrees higher than the surrounding air.

Atkins : What we understand by cable heating in this country is

laying cables on or just above the bottom of the bed and heating them, usually by low voltage. Edwards carried out some experiments here last year and found the beds dried out very rapidly indeed. The Swiss method of laying cables *underneath* the bed—in the bed structure—is quite a different thing and altogether more advanced.

Middlebrook : It seems to me that the proper thing would be to have heat underneath the bed. If you put heated cables into sand in which cuttings had been placed to root, obviously the sand would dry out, but if put below the staging it would warm the material indirectly and might be an advantage.

Question 26. What is the cure for Dactylium?

Middlebrook : The obvious thing to do, immediately you see a spot of *Dactylium*, if only a square inch, is to put on formaldehyde. If you wait till to-morrow the whole house may be full of it. Use a 2% solution of formaldehyde sprayed on the spot and six inches all round it.

Atkins : Middlebrook is always telling me he has no use for textbooks, but I believe he has been reading one or two (laughter).

Lambert : We find it just as well to dust on calcium hypochlorite.

Question 27. How do Americans spawn their trays without unstacking them?

Lambert : Where there is one inch or two inches between them they use a shallow scoop that fits in between the trays. They put the desired amount of grain spawn or ground-up spawn in the scoop and reach under the tray and scatter it around.

Question 28. Is Penicillium a parasitic fungus—parasitic on mushrooms?

Edwards : We do not think so.

Lambert : I do not know of any parasitic *Penicillium*. We have some green moulds that are quite definitely parasitic ; I think they are species of *Trichoderma*.

Question 29. Which pay best : Brown mushrooms (which are supposed to yield a greater weight) or White (which fetch a higher price)?

Middlebrook : Obviously the white pay best ; they are in public demand. It is a remarkable fact that brown mushrooms are more resistant to disease, easier to grow, and better to eat ; but if we all grew them we should not be able to sell them. The proper thing for the M.G.A. to do is to educate people into buying those mushrooms which are definitely better to eat.

Atkins : Those who grow brown mushrooms say brown are more profitable ; those who grow white mushrooms disagree.

Bels : In Denmark, growers get more money for brown than for white.

Question 30. When extractor fans are used, is air extracted from the bottom of the house or the top?

Edwards : It depends where you put the fans (laughter).

Middlebrook : To get proper circulation you would have to have the upper vents closed. You could do nothing with a fan if you had the top ventilators open and not the bottom.

Edwards : An extractor fan at the top, an inlet at the bottom, plus heating, and you will get a steady flow right through.

MUSHROOMS BY RAIL

Different Rates Available

Most growers send their mushrooms to market by rail, but inquiries received by the Secretary suggest that little is known concerning the different arrangements which we can make with British Railways to reduce our transport charges.

If we send at **Railway Risk**, British Railways accept responsibility for total loss, partial loss, damage and delay—unless they are able to prove there has been no negligence on their part. Total loss means loss of a complete basket—not necessarily of the whole consignment. Responsibility for delay is limited by the degree of deterioration due to delay; if mushrooms delayed on rail should miss the normal market, but are in good condition when delivered, they do not accept responsibility for subsequent deterioration pending the holding of the next market.

If we send at **Owner's Risk**, the railway liability for total loss is substantially the same, but is much more limited in respect of partial loss or delay. Partial loss or pilferage must be pointed out on or before delivery, and liability will only be admitted if the basket is covered with substantial material not readily removable by hand. (A paper cover secured by rubber bands, for example, would not be considered sufficient.) In the event of damage, we must prove there has been wilful misconduct by the railway staff. Deterioration in value due to delay must equal or exceed 75% of the original value and must be pointed out on or before delivery; moreover, normal transit time must have been exceeded by at least 36 hours.

There is one other important limitation which is common to both Railway and Owner's Risk rates. Complaints must be made in writing within three days of delivery in respect of partial loss, damage or delay, and the claim must follow within seven days of delivery. Written complaint of total loss is required within 14 days of despatch and the claim must be made within 28 days.

We are able to inspect certain of the Railway Books, particularly the Book of Rates (which incorporates the Distance Book) and the Book of Regulations (Section 59 of which contains in full the conditions of which the foregoing is a summary).

If a grower can negotiate a substantial reduction in his transport charges under Owner's Risk conditions he usually finds it worthwhile. If the difference amounts to only a few pence it is commonsense to send at Railway Risk, but a reduction of 50% is not unknown. The following comparisons are interesting:—

At Railway Risk	5 lb.	10 lb.	20 lb.	40 lb.
16 to 30 miles	1/4	1/10	2/5 ..	3/6
76 to 100 miles	1/11	2/9	4/2	7/1
151 to 200 miles	1/11	2/9	5/-	9/1
At Owner's Risk	5 lb.	10 lb.	20 lb.	40 lb.
16 to 30 miles	1/1	1/2	1/10	2/6
51 to 100 miles	1/2	1/10	2/10	4/10
151 to 200 miles	1/2	1/10	3/4	5/9

These are fairly representative, but we have in the same scales

15 lb. for any distance over 250 miles Railway Risk $\frac{3}{4}$ against Owner's Risk $\frac{1}{11}$. In all cases except perhaps that of 5 lb. for 16 to 30 miles it is probably worthwhile requesting the Owner's Risk rate. It should be noted that request for such rates must be in writing and, preferably, on the Railway's own consignment note.

In each case the charge includes collection from sender's premises if within the usual free cartage area (a radius of about two miles) and delivery to markets within a similar area. The distances from sender to markets are calculated on the shortest available route irrespective of the route travelled.

Let us next consider the position with larger consignments. The 1 cwt. rates at Railway Risk are graduated according to mileage, and representative figures are : 20 miles $\frac{3}{3}$, 30 miles $\frac{4}{1}$, 40 miles $\frac{5}{-}$, 50 miles $\frac{5}{9}$, 75 miles $\frac{6}{11}$, 100 miles $\frac{8}{2}$ per cwt. minimum, and greater weights *pro rata*. Collection and delivery are not included. Over 100 miles the rate per cwt. is increased by approximately 0.53 pence for each mile, e.g., 150 miles $\frac{10}{5}$, 200 miles $\frac{12}{7}$.

Reference has already been made to the quotation of rates chargeable on consignments of 56 lb. or more at Owner's Risk. When will it be worth our while to ask for such a quotation? This varies from weights of 30 lb. up to weights of 50 lb. and anything over the latter weight will almost certainly be cheaper at a minimum 56 lb. quotation. If your **average** consignment exceeds 30 lb., then, we should ask for a **special rate**.

Then there is the **point-to-point rate**, which is usually quoted only on request. Once "on the Book," however, it is available for any grower's traffic. It operates between two specified stations, almost invariably at Owner's Risk with minimum charge for 56 and/or 112 lb. It is not usual for quotations to be made unless there is a regular flow of traffic, and collection and delivery charges are not included unless requested.

There is yet another method of charging which does not appear in the Rate Book. It is referred to as the **agreed charge** and British Railways require that substantially the whole of the trader's traffic be carried by rail. It may be a flat rate irrespective of the distance carried, a flat rate per chip, or even a flat rate per consignment. From our point of view the advantage of such an arrangement is that carriage charges can be estimated much more readily in advance, and the checking of the Railway Account is very much simpler. These Agreed Charges are not applicable to other growers' traffic unless individual agreements have been entered into. The division of liability for loss, delay and damage should be agreed at the time.

It is almost always advisable to open an account with the Railway. Application should be made in the first instance to the local Parcels Agent or Station Master, although he will not have personal authority to make the arrangement. There are two types of account. What is known as a **Station Credit Account** is either weekly with payment due within the ensuing week, or monthly terminating on the 25th of each month and payment due by the end of the month. A **Ledger Account** may be either weekly or monthly, but the latter is made up to the month end and 25 days are allowed for payment.

PRESS CUTTINGS

The conditions of **grant-aid for farm water supply** schemes installed by owners and occupiers of agricultural land have recently been reviewed and two major changes are being made. Grant-aid will now be available for schemes covering all types of agricultural and horticultural food production, instead of being confined to cattle and milk production . . . Forms of Application (4724A) and further details can be obtained from County Agricultural Executive Committees.

Horticultural Advertiser, 22.3.50

The home producer has a right to first place in the home market ; therefore some **regulation of imports** should be permitted in the manner considered appropriate to each country. This principle was affirmed in Paris last week when a conference of horticultural representatives of I.F.A.P. member-countries of Western Europe met to consider the further liberalisation of trade for horticultural produce.

Nurseryman & Seedsman, 23.3.50

The Minister of Labour, Mr. George Isaacs, said in the House of Commons : As the distribution of manpower is now such that the **Control of Engagement Order** can safely be withdrawn, the Government . . . has decided . . . to revoke this Order as from the end of the week and to discontinue entirely the use of the power of direction.

Horticultural Advertiser, 15.3.50

Last week I was trying to persuade a neighbouring farmer who grows mushrooms as a side line to join the Mushroom Growers' Association and send some money along to the Mushroom Research Association. His answer was a **firm refusal** because, he said, the more he knew about mushrooms the worse became his crops.

Jack Ashton in The Grower, 13.5.50

It is neither impossibly difficult nor especially expensive to set aside some of the best produce for **show** purposes, and the **publicity** thus given to home-grown fruit and vegetables is well worth the trouble. It is yet another shot fired in the battle against imports.

Leader in The Fruit Grower, 27.4.50

Extending his mushroom-growing activities is Lt. Col. E. Noel, of the Mushroom Farm, Godstone, Surrey, who is renting a deep air-raid shelter at Epsom for the purpose. Mushroom-growing seems to rival fruit-growing in its appeal to **former serving officers**.

Fruit Grower, 13.4.50

" **Rural studies** " class at Montem School, Slough, grows mushrooms.

Sunday Express, 30.4.50

The bed should be made of **fresh horse-droppings**, about 2½ feet thick, freed from straw and robbed of their rankest heat by heaping them up and thoroughly turning them two or three times in the course of a week before finally building up.

Mrs. M. Grieve : Fungi as Food and Medicine (Date unknown).

FRANCE ON IMPORTS

M. Dekeirel replies to Mr. Boulanger

Members will recall that at the last annual meeting Mr. F. L. Boulanger (Surrey) told us that he had torn up a cheque he had just made out to the Research Fund on receiving a copy of the French Growers' Bulletin containing a translation of the M.R.A. formula for synthetic compost. "Why should I send a cheque to our Research Station when all the results go to France?" he asked. "They go to friends of mine who are delighted to compete with me and send over here mushrooms selling in London at 2/- and 2/6 a pound."

Monsieur P. Dekeirel, Honorary Member of the M.G.A. and Administrative Secretary to the French growers, makes this comprehensive rejoinder :

We did not publish any formula in our Bulletin. We only communicated to some of our growers a translation of the report on the M.R.A. synthetic compost. For this we had your authorisation—just as we very gladly gave you authority to publish a translation of the article on casing soil by Mons. Courtieu.

Mr. Boulanger intimated that he did not mind the M.R.A. divulging results to Americans and Dutchmen, presumably being under the impression that they could reciprocate, but resented them coming to France. He forgets that it was France which began growing mushrooms commercially and first discovered a process of pure-culture spawn production. The English experiments on synthetic compost, too, were inspired by the work of Labrousse, Demolon, Burgevin, Marcel, Boischot and Barbier. It cannot be said that we have failed to contribute to the progress of mushroom culture.

England, America and Holland are going ahead with their research, but we trust we shall not lag behind, for we are establishing our own Mushroom Research Laboratory near Paris.

There is another point. Some of your English methods are not adaptable to French caves. Mr. Boulanger's brother, a grower at Montataire in France, should know something about that ; he tried to imitate your processes and the thing miscarried.

As to prices, the average price of mushrooms in 1949 in the Paris Halles Centrales was 1/6 per lb. The mushrooms we sell in England are of the best quality, but not being trimmed and undergoing some depreciation during transit, they are naturally sold in London at somewhat lower prices than are obtained by English-grown mushrooms.

So far this year we have exported to you only 35 per cent. of the figures for the same period a year ago. In 1949, our exports totalled 450,000 lb. ; during the first quarter of 1950, we sent you only 39,380 lb.

All these figures are taken from the official statistics of our Ministry of Finance, derived from bonder declarations.

We have sent you during the first three months of 1950 about 21,000 lb. of canned mushrooms (including wild mushrooms and truffles). It is probable, of course, that America also is sending you canned mushrooms.

We need not add that we were very happy to learn that your Chairman, Doctor Edwards, and Mr. Atkins, replied at your meeting to Mr. Boulanger's remarks.

P.D.

Fungi that Trap Eelworms

By

Dr. C. L. DUDDINGTON, M.A., Ph.D., F.L.S.

Most mushroom growers are familiar with the minute nematode worms, popularly known as eelworms, that have recently been causing trouble in mushroom beds, but it is not generally known that these destructive animals are themselves liable to attack by fungi. The eelworm is a vigorous and swiftly moving animal, and many of these fungi show remarkable adaptations to enable them to capture their living prey. Some possess sticky nets by means of which the eelworm is captured as a bird is caught by bird-lime; others have sticky knobs which serve the same purpose, while some, most remarkable of all, are provided with nooses by which the eelworm is held like a rabbit in a snare. Collectively, they are called predacious fungi.

Most of the fungi that attack eelworms belong to the group known by mycologists as the Hyphomycetes. These are microscopic fungi in which the mycelium consists of delicate threads or hyphae which are only a few thousandths of a millimetre in diameter. They reproduce themselves by means of spores, comparable in size with those of the mushroom, which are formed at the ends of erect hyphae (Fig. 1a.) There may be a single spore at the end of the hypha (Fig. 2c), but more usually they are carried in groups or "heads."

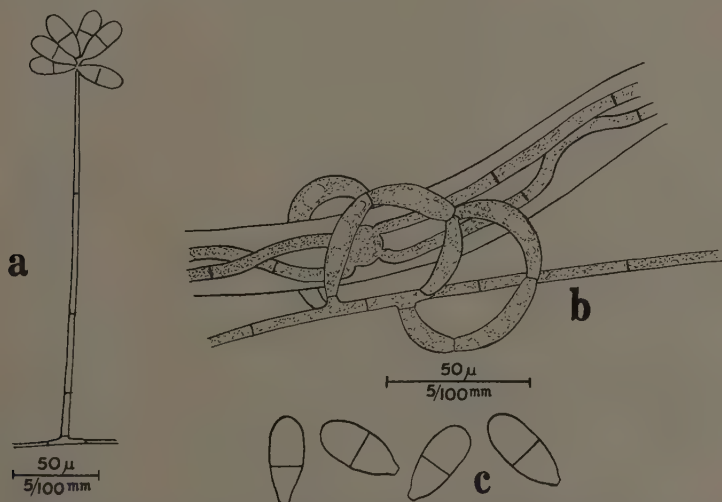


FIG. 1. *TRICHOТЕCIUM FLAGRANS*. a. Conidiophore, bearing a head of spores. b. Part of an eelworm caught in the net, showing infection bulb and trophic hyphae. c. Spores.

Trichothecium flagrans is an example of a predacious fungus capturing eelworms by means of adhesive networks. I first came across this species in a specimen of compost kindly sent to me by the late Dr. M. C. Rayner. The hyphae give off short branches which curl back on themselves and link up either with the main hypha or with other similar branches, thus forming systems of three-dimensional networks. An eelworm coming into contact with one of these sticks to it, evidently on account of some adhesive substance secreted by the fungus. For a time, the eelworm struggles violently, often becoming further entangled with the network as a result, but eventually, usually after about two hours, all movement ceases and the animal is apparently dead. A short outgrowth from the fungus then penetrates the skin of the eelworm, and swells up inside the animal to form a bulbous structure. From this infection bulb other hyphae—"trophic hyphae"—grow out into the body of the animal and absorb its contents completely (Fig. 1b), so that finally only the empty skin of the eelworm is left sticking to the fungus. In this way, eelworms may be caught in enormous numbers, and in cultures containing the fungus with eelworms on agar jelly the heaps of dead and dying animals may even be visible without a microscope. It was on account of its exceptional savagery that I gave this fungus its specific epithet *flagrans*.

Spore-formation by *T. flagrans* usually occurs after the fungus has fed liberally on eelworms. The spores are formed in heads at the ends

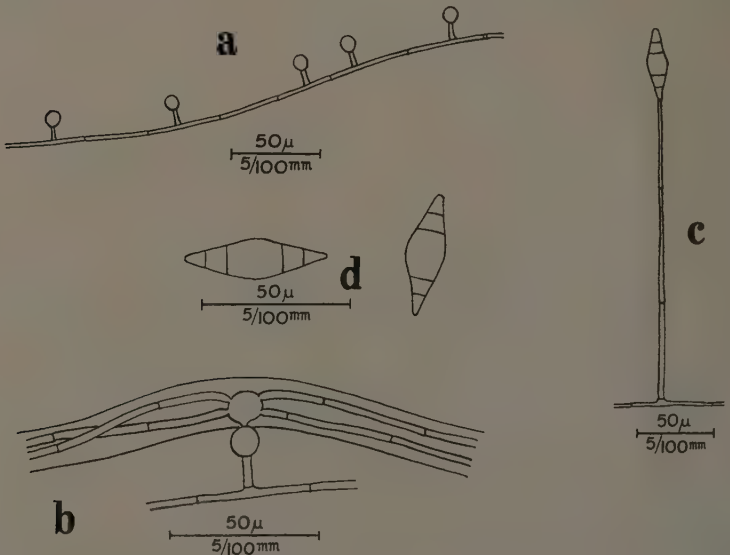


FIG. 2. *DACTYLELLA ELLIPSOSPORA*. *a*. Hyphae with adhesive knobs. *b*. Part of an eelworm caught by a knob, showing the infection bulb and trophic hyphae. *c*. Conidiophore bearing a single spore. *d*. Spores.

of special hyphae (conidiophores) which stand up vertically, holding the spores up into the air, where they may be dispersed, possibly by air currents, or perhaps by sticking to passing insects, etc. (Fig. 1a). The spores are pear-shaped, and each spore is divided by a partition into two cells (Fig. 1c). The spores germinate quite easily under suitable conditions; the germinating spore puts out a germ tube from one or both of the cells, which grows into a hypha from which a new mycelium is formed.

No less than fourteen other species of fungus are known to capture eelworms in sticky networks. Of these, the best known and the commonest is *Arthrobotrys oligospora*, which fairly closely resembles *Trichothecium flagrans*. *A. oligospora* was first discovered nearly a hundred years ago, but it was not until it had been known for the best part of fifty years that its relationship with eelworms was observed. A closely related species of *Arthrobotrys*, not yet named, has been found in an old mushroom bed; for a specimen of this fungus I am indebted to Dr. R. L. Edwards, of the Mushroom Research Association.

Dactylella ellipsospora is a typical example of a fungus which uses adhesive knobs for capturing eelworms. The history of these species parallels that of *Arthrobotrys oligospora*, for although it was first described under another name in 1851, it was not until 1937 that Drechsler, in America, first showed that it was predacious on eelworms. The mycelium of *D. ellipsospora* consists of delicate hyphae which bear at intervals short branches, each branch ending in a nearly spherical knob (Fig. 2a). These knobs secrete an adhesive substance, so that eelworms coming into casual contact with them are held fast. The knobs only are sticky; contact with the hyphae themselves does not harm the eelworm.

When the animal has ceased to struggle, its skin is penetrated by an outgrowth from the knob, which forms within the animal an infection bulb similar to that formed by *Trichothecium flagrans*. Hyphae grow out from the bulb and spread throughout the carcass of the eelworm, absorbing its contents and passing the material back to the fungus (Fig. 2b). Ultimately, the body of the eelworm is completely emptied, leaving the skin attached to the knob. Spore formation usually occurs after a number of eelworms have been consumed. As before, the spores are carried aloft on erect conidiophores, but, as in all species of *Dactylella*, only one spore is formed at the tip of each conidiophore, and every spore consists of several cells (Fig. 2c, d). A number of other fungi are known which capture eelworms by means of adhesive knobs, all belonging to the genera *Dactylella* and *Dactylaria*.

Most remarkable of all the predacious fungi are those which catch their prey by means of constricting rings. The best known of these is *Dactylella bembicoides*. The organs of capture here consist of rings, each composed of three curved cells and attached to the mycelium by a short stalk (Fig. 3a). The inside diameter of the ring is about that of the eelworms on which the fungus preys. The stalks carrying the rings are so arranged that they stand up vertically from the surface of the substratum on which the fungus is growing, the rings being held like rabbit snares. When an eelworm happens to push its head into a ring, the

three cells quickly swell to several times their former volume, so that the opening in the ring is almost obliterated (Fig. 3b). The unfortunate eelworm is thus squeezed tightly by the expansion of the ring and firmly held, in spite of desperate struggles to get away (Fig. 3c). Death of the eelworm follows soon after capture, and its carcass is then invaded by hyphae which grow out from the cells of the ring and, filling the body of the animal, absorb its contents.

After a period of feeding on eelworms, spores are formed. The spores of *Dactylella bembicoides* are not unlike those of *D. ellipsospora* and, like them, are carried singly at the ends of erect conidiophores (Fig. 3d). A number of fungi, belonging to the genera *Arthrobotrys*, *Trichothecium*, *Dactylella* and *Dactylaria* capture eelworms by means of constricting rings like those of *Dactylella bembicoides*.

In addition to the predacious fungi of the kind described here, quite a number of fungi are internally parasitic in eelworms. Most of these—e.g., *Harposporium anguillulae*, *Acrostalagmus obovatus*—have adhesive spores which, sticking to the skin of eelworms that come into casual contact with them, penetrate the host animal by means of a germ tube that gives rise to a mass of hyphae within the body of the eelworm. After the contents of the animal have been consumed, hyphae grow out through the skin of the host and form more spores outside it, thus spreading the infection.

The predacious fungi are a very widespread group. Of seventy species known to attack eelworms, thirty have so far been found in Britain. They may occur wherever eelworms are found: in compost, leaf-mould, dung, decaying plant materials of all kinds, and they appear to be particularly abundant on mosses, which usually harbour eelworms

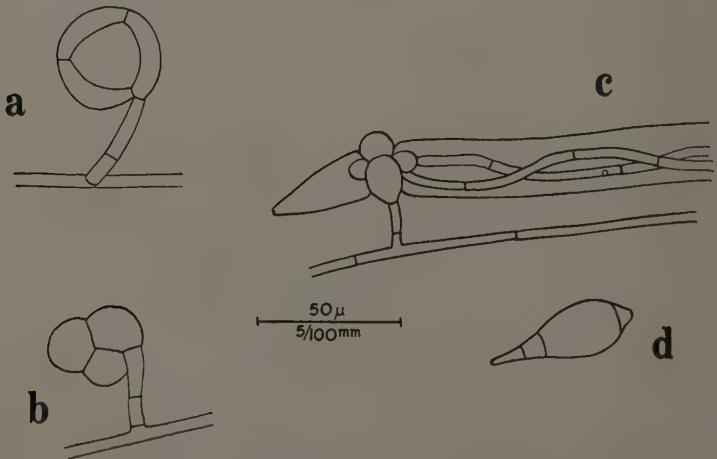


FIG. 3. *DACTYLELLA BEMBICOIDES*. *a*. Loop, open. *b*. Loop, closed. *c*. Part of an eelworm captured by one of the constricting rings. Trophic hyphae can be seen growing out of the ring, inside the eelworm. *d*. Spore.

in large numbers. Very little is known about the part they play in limiting the numbers of eelworms in nature, but it seems likely that they must be an important factor. Attempts to find a means of using them for controlling eelworms that attack crops have not up to now been successful, but little work has been done on this, and it is by no means impossible that we have in these curious fungi a means of limiting the inroads made by eelworms on cultivated plants. Much work remains to be done, however, on the nature and habits of the predacious fungi before they are likely to be of any economic use.

MY WAY OF GROWING

3—"Loch Leven" Mushrooms (John Beveridge)

The following article was written by Robert A. S. Coldwell, Station Master at Kinross Junction, in collaboration with William D. Painter, Staff Clerk, D.O.S.O., Burntisland, and is reproduced with acknowledgments to the authors and to the *L.N.E.R. Magazine* in which it first appeared (February, 1941).

It is truly said that necessity is the mother of invention, and this has certainly proved to be the case at Kinross, where the management of a factory situated on the banks of Loch Leven, finding that there was no outlet for their tweed products, during the trade depression, experienced some eight years ago, decided to experiment in the cultivation and sale of mushrooms.

An influencing factor in this decision was the imposition at this time of a tariff on imported mushrooms from France, which placed growers in this country in a more favourable position than had hitherto been the case.

The experiment referred to was originally confined to a room in the factory and the results proved so satisfactory that the remaining machinery in the factory was dismantled and the cultivation of mushrooms began on an extensive scale. The factory was partitioned into what are known as "houses." In these, wooden "beds" are constructed in tiers almost reaching to the roof, and supported on steel scaffolding. Between 300 and 400 "beds" are now in full use.

The preparation of the beds is an altogether interesting process. Wheat straw manure to the extent of 30 tons weekly is purchased, and treated in a shed which has been specially set apart for the purpose. Here the manure is sufficiently rotted and broken up by frequent turning over, during which operation it is disinfected. When the manure is judged to be in a proper condition, it is placed in the "beds" to a depth of 7 inches. It is then allowed to lie in the "beds" till it reaches a certain temperature, after which what is known as the "spawn" is planted in the manure, small pieces being placed about 9 inches apart and in a diagonal formation across the beds. This "spawn" is purchased from laboratories in England, where it is scientifically prepared. The "spawn" quickly spreads or runs throughout the "bed" and two weeks after "spawning" a layer of soil 1 in. deep is placed on top.

This soil is specially selected. Clayish soil, desirable because of its moisture conserving property, is broken up by riddling and crushing. This is mixed with a proportion of ordinary soil and lime, and the whole is sterilised by a steam process.

The "houses" are kept at an even temperature of about 60 deg. and the mushrooms begin to appear in six to eight weeks' time. The "beds" must then be lightly watered daily, and to keep down fly pests, etc., the "houses" are regularly sprayed with insecticides.

From the time that the mushrooms appear, ten days elapse before they are ready for pulling. The pulling process, which is performed by girls, must be carefully carried out. The mushroom is broken from the stalk, which in turn is gently detached from the main growth and the cavity thus made in the "bed" is refilled with soil in order to encourage the development of other mushroom heads. It is a most delightful sight to see the "beds" thickly clustered with mushroom heads in their various stages of growth, the white or creamy colour showing up well against the dark brown colour of the earth covering in the "beds." The "bed" continues to yield further supplies after the first picking for approximately ten weeks, when the "bed" is completely emptied, and the manure compost, which is rich in the humus beloved of gardeners, is sold to nurserymen, etc.

The successful cultivation of mushrooms is largely dependent upon the maintenance of a steady temperature and careful watch is kept upon the climatic changes from day to day, special steps being taken to counteract the effects of abnormally cold or warm weather which would otherwise have an adverse effect on the maintenance of regular supplies.

The industry gives employment to over 30 men and girls, and it is interesting to note that the coal consumption for heating and sterilisation amounts to 500 tons per annum.

The mushrooms are cropped daily, graded and packed into 3-lb. and 5-lb. chip baskets for despatch. A ready market, even under the present emergency conditions, is available in the larger towns in Scotland and England, and approximately 200,000 lb. of this traffic are forwarded annually by passenger train from Kinross Junction station.

It is natural that the name "Loch Leven" should be associated with produce emanating from the historic town of Kinross, and so well established has this unique industry become that "Loch Leven" mushrooms now enjoy a widespread reputation.

FARM WORKERS' WAGES

The General Secretary of the Horticultural Trades Association points out in the *Horticultural Advertiser* of 19th April, that, in spite of the general political talk of "wage-freezing," the President of the Agricultural Workers' Union (Mr. Edwin George Gooch, C.B.E., M.P.), has recently publicly stated that he did not believe this was the time to "freeze" the wages of land workers. The worker should "share a bit more in the undoubted prosperity" of the industry.

The agenda of the Biennial Conference of this trade union shows that no fewer than 154 of its branches have submitted demands for a higher minimum wage. These demands range from a £5 minimum for a 44-hour week, to £6 10s. 0d. minimum. Another lot of resolutions ask for a substantial increase without naming any figure.

A Modern Italian Farm

An excellent account of a modern mushroom farm in caves near Vicenza, between Milan and Venice, in Italy, has now reached us through the courtesy of Colonel Rocke, whose son-in-law, the Count da Schio, is the owner. The Count is an overseas member of the M.G.A.

His father started mushroom growing prior to the 1914/18 war, but the venture was brought to a close by his death at that time. Count da Schio, who was keen enough to take an honours degree in Horticulture in 1932 with a thesis entitled 'Mushroom Cultivation as a Commercial Undertaking,' started growing in 1946.

The caves, which are famous in Italian history, are 3,000 years old and man-made, and are admirably adapted for mushroom growing, as there is unlimited room provided by 14 'halls' or chambers each with floor space of 54,000 square feet and independent of the other, but joined by a motor road a mile-and-a-half long. The walls and roof of each chamber have been cut out of solid rock and are smooth; the floors are of cement. Electricity has been laid on and ventilation is provided by underground and overhead pipes. With this equipment it was obvious that a combination of the latest known methods of growing should be combined with the usual French cave methods of culture.

PRODUCTION : About 200 lb. of mushrooms are produced daily, although this figure is varied to suit the market; during the Autumn (September to November) wild mushrooms are available and production is slowed down for this reason. The farm is developing and the production figure will be increased as more beds are laid down. During 1949,



One view of the Vicenza Caves, showing system of aeration by compressed air through ventilating shaft at back of picture. Note the flat roofs, clean walls and cement paths.

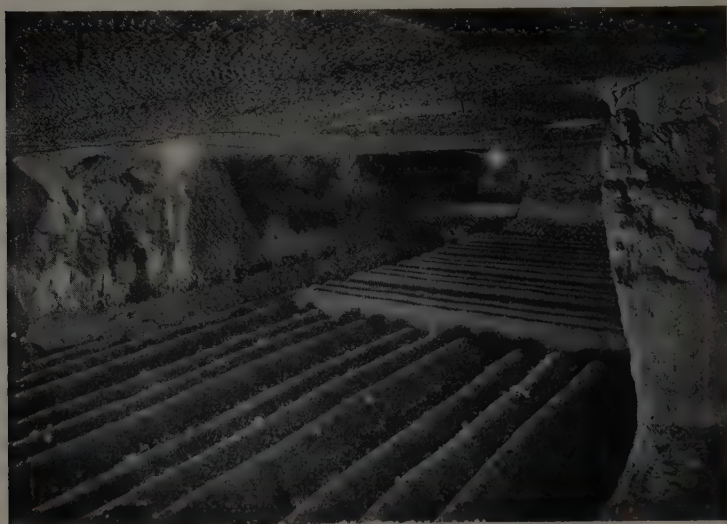
a number of chambers produced $1\frac{1}{2}$ lb. of mushrooms per cubic foot of compost, which is a high yield from ridge beds. According to the time of year, and the demand, between 7 and 18 workers are employed in the caves. The wholesale prices vary from 1/10 to 3/6 per lb., and the retail from 3/- to 5/6 per lb. A good market awaits the compost after the beds are cleared.

COMPOST : The manure is obtained from several large stables near by and is turned from 3 to 5 times according to its requirements. Gypsum and sulphate of ammonia (standard Continental practice) are well mixed into the piles.

SPAWN : French spawn is planted, about 6" apart, but the owner hopes shortly to make his own.

CASING MATERIAL : This is ground rock from the caves themselves, mixed with river sand and humus, sterilized, and put on to a depth of about $\frac{3}{4}$ ".

DISEASE PREVENTION : A great deal of the success of the concern is attributed to the measures taken against pests and diseases and to the strict disinfecting which takes place after each cave is emptied. A certain amount of White Plaster Mould has been experienced, but this has been overcome, largely, it is believed, through the excellence of the spawn used. Apart from this and certain pests which are kept down with DDT, the caves are free from trouble. A long 'rest' period is allowed each cave between crops which helps in the control of diseases, pests and competitors, and the fact that the floors are of cement, and the walls and roof of each 'hall' are free from fissures, greatly assists the cleansing programme. Disinfection is carried out with salts of copper, quicklime, and hypochloride of lime.



The first flush is just appearing.

Count da Schio extends a cordial invitation to any member of the M.G.A., with an introduction from the Secretary, to visit his 'modest little industry' at any time of the year, preferably between December and August.

Dr. James W. Sinden on

Geotrichum Control

Dr. J. W. Sinden, Life Honorary Member of the M.G.A., wrote in M.G.A. Bulletin 18 (p. 15) from Pennsylvania State College suggesting 15% sodium hypochlorite dust as a control for *Sporendonema*—known to growers over here as *Geotrichum*.

Several days later a member wrote to say he had been unable to obtain *sodium* hypochlorite dust as it was not stable. We asked Dr. Sinden his opinion on its substitution by *calcium* hypochlorite dust. He replied :

"I agree with the use of the calcium hypochlorite. In fact there is no real reason for looking for the sodium, as I think the former will perform as well.

"We have various commercial preparations here such as H.T.H. and Oakite which may be obtained as hypochlorites in powder form. These are used as solutions for spraying dairies, stables and other such places. They or calcium hypochlorite may be diluted with clay or talc and sprinkled dry directly on the patch of mould such as *Sporendonema* or of *Dactylium* and will act rapidly to kill the fungus invader without leaving the bed permanently affected.

"As the action depends on the release of chlorine the effect is temporary and will not injure mushrooms at any distance from the point where it is sprinkled. By no means should it be dusted over a whole room.

"This method of treatment with the dry hypochlorite was discovered by one of our growers, Mr. Michael Swanik, of Wampum, Pa., who was seeking to control *Dactylium* in a mine. With it he cleaned out the *Dactylium* in the course of a few months. The same method tried at the Butler mine is also proving very successful."

MEMBERS' CHANGES OF ADDRESS

GROWER MEMBERS

- S. Icklow, Carabis Nurseries, Pick Hill, Waltham Abbey, Essex.
 A. D. Sanger-Goldsman, Mayfield Nurseries Ltd., The Avenue, Rowledge, Nr. Farnham, Sussex.
 J. Z. Sala, Mushroom Barn, Broadbridge Heath, Horsham, Sussex.
 W. S. Atkinson, Blackgates Farm, Tingley, Nr. Wakefield.
 D. J. Palmer, The Orchard, Semington, Trowbridge, Wilts.
 S/Ldr. H. J. Robinson, Lynvale, W. Baldwin, Marovin, I.O.M.
 W. Wallace, Inglenook, Berrow, Nr. Malvern, Worcs.
 Lt. Colonel J. E. B. Freeman, Buxhall Vale, Stowmarket, Suffolk.

HONORARY MEMBERS

- Colonel J. P. Kellett, D.S.O., M.C., New Amberden Hall, Debden Green, Saffron Walden.
 W. R. Atkinson, West Dock Timber Co. Ltd., Manchester Street, Hull.

“Mushroom Growing To-day”

J. L. KESSLER REVIEWS NEW BOOK

Mushroom growers appear to be of two kinds ; those who follow the well trodden path aided, perhaps, by some of the new gadgets and scientific paraphernalia, but are in the main content to grow mushrooms on much the same lines as have been followed for the past half century, and if they produce an average of $1\frac{1}{2}$ lbs. per sq. ft. of bed, they are not dissatisfied with their achievements. Mr. Atkins is clearly of another stamp and this latest work of his, forming as it does an up-to-date manual of mushroom culture, might be said to embody the Yaxley outlook and all that Noble Mushrooms and the M.R.A. Research Station stand for in scientific and very thorough approach to the subject.

If some of us, who belong to the first category, do not entirely agree with all Mr. Atkins' views, it does not mean that we can afford not to read and study this book, for we are sure to find stimulation and information and may well be provoked into more systematic and careful methods. How many of us, I wonder, take all the trouble in composting our manure that Mr. Atkins describes in such detail, and with the aid of very clear drawings ! Yet, is it not this very thoroughness, perhaps, the basis of the high yields obtained by Noble Mushrooms Ltd.?

Mr. Atkins advocates a square pile ; we always point ours in the manner he describes in giving Dr. Sinden's method of quick composting. Which is right ? This is the sort of intriguing question that will arise in every mushroom grower's mind when he reads this book. Besides manure compost the author describes how to prepare the M.R.A. Synthetic Compost and lists the ingredients.

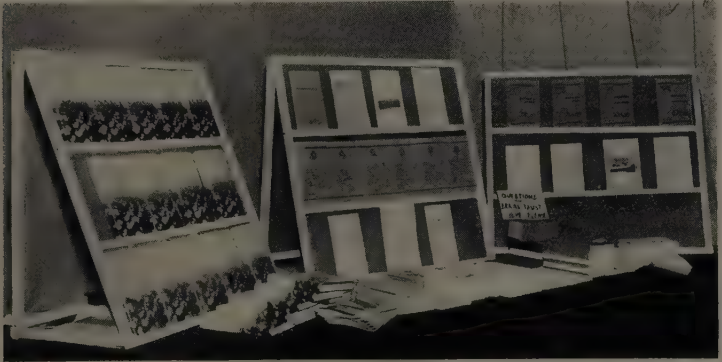
Mr. Atkins was a brave man to publish a list of Sundriesmen and Purveyors of Growers' Requirements, and I hope he will not be lynched by the ones he has left out !

Clearly the book is intended very largely for beginners, but I was a little surprised to read in the opening sentence that mushrooms and other fungi are not plants. I was taught that fungi were classed as Cryptogamous plants, but perhaps Botany has changed since then. One can well understand the need for simple explanation but surely it would be wiser not to depart from the accepted botanical classification ? Do spores have to be referred to as 'seeds,' which, being asexual in origin, they are not ?

All sides of mushroom growing are dealt with from ridge beds to tray system, though considering the interest now taken in the latter, I thought the chapter dealing with the Two-Zone system rather disappointing. I particularly like the chapters on pests and diseases, but it is unfortunate that—doubtless unavoidably—some of the very excellent photographs, with which it is illustrated, are far removed from the text to which they refer and, in addition, it would have been helpful if the scale of magnification of the drawings of the pests had been indicated.

The binding is pleasing, in a good compost colour, with a picture of a mushroom on the back which will give ready identification on the bookshelf. It is noteworthy that this mushroom is an immature 'button,' and, seeing that this is Mr. Atkins' first major work, there may be more to follow and, in good time, we may look forward to a fully developed 'cup' and eventually, as cultural methods change, to an 'open.'

This book is a practical grower's guide to mushroom growing and is clearly the product of much diligent research, reinforced by careful observation and experience, and I have no hesitation in recommending it to all growers and would-be growers.



"Mushroom Growing To-day" by Fred C. Atkins (published by Faber & Faber at 12/6), is obtainable through any bookseller or from the M.G.A. Secretary. Here it is seen (left) on the M.G.A. Stand at the Open Day, when 100 copies were sold before lunch.

CHELSEA SHOW. The N.F.U. Market Produce Show Society's stand at Chelsea this year was again a magnificent sight. Sir Oliver Leese, who is the M.G.A. representative on the Society, was asked to provide mushrooms for display, and through the co-operation of our Chairman, Mr. A. DeB. Hovell, the following members generously sent produce: Messrs. F. L. Filmer, A. DeB. Hovell, A. G. Sparkes, H. G. Boxall and Walden Brothers.

Additions to the Library: *Bulletins 2, 3 and 4* (February, March and April, 1950) of the French M.G.A., presented by the French growers; *U.S. Plant Disease Reporter*, Vol. 33, No. 6, 1949 (containing article by Lambert, Steiner and Dreschler on "*Cephalothecium Disease*"), presented by the U.S. Dept. of Agriculture; *Scientific Horticulture*, Vol. 9 (1949), presented by Noble Mushrooms Ltd; *Darlington's Mushroom News*, Vol. 11, No. 5, presented by W. Darlington & Sons; the *N.F.U. Annual*, 1950; the *Women's Farm and Garden Associations' Year Book*, 1950; *Report for Year 1949*, presented by the Mushroom Research Association Ltd.; Fred. C. Atkins's *Mushroom Growing To-day*, presented by W. A. B. and N. D. Harding.

First International Conference on Mushroom Science

**Dr. R. L. EDWARDS DESCRIBES
REMARKABLY SUCCESSFUL MEETINGS**

Early this year a proposal was received from the Horticultural Department of the Dutch Government that a Conference of scientists engaged in mushroom research should be held to discuss their problems, state of progress, and methods of investigation. Joint discussion of their research programmes might also ensure that no important problem would be overlooked, and that two laboratories would not carry out identical work, which would be wasteful. It was suggested that the Conference might be held in England, and organised from Yaxley. We received the idea with enthusiasm, and a Committee was formed to carry it into effect, consisting of Mr. Fred. C. Atkins (*Chairman*), Dr. P. J. Bels, Dr. E. B. Lambert, and Dr. R. L. Edwards (*Honorary Secretary*).

A list of scientific workers engaged in research on mushrooms or in applying research, was made, and invitations to take part in the Conference were sent to them. It was considered important to keep the number small, and still include anyone with a contribution to make, so that discussions would be easy and informal. The final membership was 41, from U.S.A., Britain, France, Switzerland, Belgium, Holland, Denmark, and Sweden; 30 papers on all aspects of mushroom growing and research were read by 18 members from 6 countries, and all took part in the discussions and many personal exchanges of views which followed them. **The collected papers are to be published, with reports of the discussions.**

The Conference started on Wednesday, 3rd May, when members were entertained to dinner by Mr. A. DeB. Hovell and members of the M.G.A. Executive Committee. Mr. Hovell welcomed the assembled scientists, and remarked on the increasing scientific interest in mushroom problems shown by the formation since the war of mushroom research institutions in Britain, Holland, France, and Belgium. He wished the Conference success in its efforts to throw more light on the mysteries of mushroom growing.

In reply, Dr. E. B. Lambert thanked the M.G.A. for their hospitality and interest in the Conference. *He said that it seemed like a miracle to see so many people from different countries assembled to discuss mushrooms.*

Dr. P. J. Bels complimented the British mushroom industry on its Mushroom Growers' Association, *the best of its kind in the world*, and on its Research Station. He said that Continental scientists were pleased to have this chance to meet and compare notes and hoped that this was the first of many such Conferences. During that and subsequent evenings, mushrooms were discussed as never before in the various hotels of Peterborough.

On Thursday, M.R.A. Open Day, members of the Conference visited the Research Station and Noble Mushrooms Ltd.

Serious business started on Friday, 5th May, with an Opening Address by the Chairman, who contrasted this assembly with the secrecy which once prevailed among mushroom growers, and welcomed the Conference as a step towards better knowledge and control of the mushroom crop. This was followed by papers and discussions on various systems of mushroom growing. On Saturday the Conference visited Mr. J. Stewart-Wood, who very kindly showed them round his farm at Aylesbury. There was much discussion of composting methods and ventilation for shelf and tray systems of growing.

On Monday to Thursday there were groups of papers on Experimental Methods, Casing Soils and Air Conditions, Compost, Pests and Diseases, and Fruiting of the Mushroom. The Conference ended with an outline of the work contemplated in various laboratories, followed by a short concluding address by the Chairman. There was an epilogue in lighter vein by two members who sang a multi-lingual song, composed late the previous evening in honour of the occasion.

A list of papers read at the Conference is given at the end of this account. Among those of particular interest to growers were Dr. Lambert's review of twenty years research and his experiments on fortifying long straw manure ; Dr. Pizer on casing soil and compost ; Dr. Hauser and Professor Sinden on short composting and the use of Parzate ; Dr. Storey and Mr. Middlebrook on the results obtained in various types of house, with some important remarks on ventilation ; M. Sarazin on Mycogone and Bacterial Spot ; Mrs. Bels-Koning on casing and insecticides ; and Mr. Atkins on the economic cropping period.

Looking back on the Conference, when we started arranging it we wondered if anyone would come and whether we could possibly get enough papers to fill up the $4\frac{1}{2}$ days allowed for discussions. A little later we revised the programme by cutting out one of these days, but we soon had to put it back and could quite well have filled another day.

We all came away with the feeling that we have made a lot of friends with common interests ; we have all learned much and developed fresh ideas about our own work ; and we can apply, each in our own way, the combined scientific knowledge of many countries to our various practical problems.

The Conference asked that each country taking part would appoint one scientist to keep in touch with Mr. Atkins and Dr. Edwards at Yaxley, with a view to holding a similar Conference, probably on the Continent, in about three years time.

The following papers were presented to the Conference in this order :

- P. J. BELS (*Netherlands*) : "A comparison of mushroom cultivation in Switzerland, Belgium, England, Holland and Scandinavia."
- A. SARAZIN (*France*) : "Comparaison pratique entre la culture americaine sur étagères et la culture française en carrières."
- R. L. EDWARDS (*Gt. Britain*) : "Comparisons between commercial yields of mushrooms."

- H. PALUDAN (*Denmark*): "The difficulties of mushroom culture in Denmark and their influence on the general security of the culture."
- E. B. LAMBERT (*U.S.A.*): "Comments on twenty years of research in mushroom culture in the United States."
- F. C. ATKINS (*Gt. Britain*): "The economic cropping period."
- I. F. STOREY & S. MIDDLEBROOK (*Gt. Britain*): "Some aspects of seasonal cropping in two types of mushroom house."
- A. WATSON (*Gt. Britain*): "Advisory services for mushroom growers."
- E. HAUSER (*Switzerland*), J. SINDEN (*U.S.A.*) & U. HAUSER (*Switzerland*): "Low voltage cable heating in mushroom beds."
- R. L. EDWARDS (*Gt. Britain*): "Design of mushroom cropping experiments."
- P. J. BELS (*Netherlands*): "Experimental Methods."
- S. BURROWS (*Gt. Britain*): "Methods of sampling and analysis of mushroom composts and the determination of absolute changes in them."
- MRS. H. C. BELS-KONING (*Netherlands*): "Experiments with casing soils, water supply and climate."
- G. CHAPUIS & P. COURTIEU (*France*): "Le sol de gobetage."
- N. H. PIZER (*Gt. Britain*): "Some experiments with mushroom casing soils."
- N. H. PIZER (*Gt. Britain*): "Horse manure compost."
- WM. CHRISTENSEN (*Denmark*): "Technical control of composting."
- E. B. LAMBERT & T. T. AYERS (*U.S.A.*): "Yield response from supplementing mushroom composts with proteins."
- J. W. SINDEN (*U.S.A.*) & E. HAUSER (*Switzerland*): "Short Composting."
- WM. CHRISTENSEN (*Denmark*): "The effect of composting conditions on horse manure compost for mushroom growing."
- S. BURROWS (*Gt. Britain*): "Some chemical changes in mushroom composts during composting, peak-heating, and cropping."
- G. CHAPUIS & P. COURTIEU (*France*): "Le fumier artificiel."
- R. L. EDWARDS (*Gt. Britain*): "Synthetic Compost."
- WM. CHRISTENSEN (*Denmark*): "Artificial compost from straw and *Penicillium mycelium*."
- G. L. HEY (*Gt. Britain*): "The effect of new insecticides on mushroom pests."
- H. C. BELS-KONING (*Netherlands*): "Experiments on the influence of some modern insecticides on mushroom crops."
- C. A. THOMAS & CAIRNS (*U.S.A.*) (read by E. B. Lambert): "Field studies with nematodes."
- J. B. YODER, J. W. SINDEN (*U.S.A.*) & E. HAUSER (*Switzerland*): "Experience with zinc ethylene bisdithiocarbamate fungicide (Parzate) in mushroom cultivation."
- E. HAUSER (*Switzerland*) & J. W. SINDEN (*U.S.A.*): "Two new diseases of cultivated mushrooms."
- A. SARAZIN (*France*): "La môle" (Bubble).
- R. L. EDWARDS (*Gt. Britain*): "Some factors affecting fructification in the mushroom."

Major Maurice Few tells us about.....

Mushrooms in Rhodesia

Since my arrival in Southern Rhodesia last summer, that is to say your last summer, I have not given up the idea of growing mushrooms, in spite of the fact that at the moment I am engaged in learning the intricacies of growing Virginian Tobacco.

In consequence I have not ceased to inquire if anyone knows anyone who grows mushrooms in Southern Rhodesia. Eventually my patience was rewarded at a "sundowner" where I met someone who knew someone who knew two ladies who grow mushrooms in the heart of the city of Salisbury, which is the Capital of the Colony.

To-day I sallied forth and found this little Mushroom Nursery just as it had been described. Mrs. H. Griffiths, who is assisted in the business by her daughter, Mrs. Bordman, welcomed me into 80 A, Gordon Avenue, and conducted me to the bottom of the garden. There I was shown a compact little composting shed with mosquito gauze covering the windows and three cropping houses of asbestos cement walls and corrugated iron span roof with vermiculite padding beneath it and with wall ventilators beneath the eaves.

Each house contains two 3-tier beds, each bed being 14 feet by 3 feet, i.e., 252 square feet per house, totalling 756 square feet in all, and giving an average yield of $1\frac{1}{2}$ lb. per square foot.

Straw crops cannot be grown in this district; however, wheat straw is collected from the packing cases delivered to the local stores and shops, and horse manure from a neighbouring riding school. Gypsum formerly obtainable is now hard to come by and superphosphate is used in its place, Vermiculite being added to the casing soil.

The necessary humidity is obtained by draping sacks around the space above each bed. These are dipped in disinfected water twice daily, and I must say I got the impression of plentiful humidity and fresh air. Unfortunately I saw no mushrooms, the old crop being carried out while I was there and the new one cased but still waiting to break. The mushrooms are all retailed in 1 lb. and $\frac{1}{2}$ lb. paper bags, suitably stamped and sealed, at 7/6 per lb.

Mrs. Griffiths obtains her spawn from a well-known sundriesman in the South of England, who was also my sundriesman. If he reads these lines he may be glad to learn that I am told his product arrives out here in consistently good condition.

The above is in the nature of a pilot scheme. Mrs. Griffiths plans to move to the outskirts of the city and there erect a plant to contain 10,000 square feet of beds. A novelty to be incorporated in the houses I found intriguing. They are to be of cement with reinforced cement span roofs. To keep these roofs cool (I experienced 133° F. in the sun before the rains this season) a mechanical pump is planned to carry water up to and along the roof apex and there distribute it to flow down the outside of the two roof spans and thence into gutters which will carry it back to the central pump tank, thus with a ballcock to allow wastage from evaporation to be made good, the same water can be used over and over again. I intend to watch this venture.

Personally, if I launch a pilot scheme, I favour going native and digging a pit in the ground about six feet deep (not in a vlei where it would flood) and above and overlapping it a native grass roof, high spanned and therefore cool and waterproof, with the eaves a foot or two above ground level.

Then I would grow ridge beds on the floor of the pit for so long or until trouble starts, and when that happens fire the roof, decontaminate and fill in the hole and proceed to dig a new one! There is plenty of room to do that sort of thing, and as ants, termites and so on have a rooted objection to mankind erecting buildings of a permanent nature, mankind is rather apt to declare, "Hurrah for to-day and to hell with to-morrow," if you see what I mean?

"THE CULTURE OF MUSHROOMS": The latest revision of Messrs. Geo. Monro Ltd.'s technical handbook, "The Culture of Mushrooms," is well worth its place on the mushroom grower's bookshelf. It is particularly refreshing to find credit frankly and freely given to the work of the M.G.A. and the M.R.A. and to our "excellent publication," the Bulletin. Here it can be told that no firm was more co-operative or gave more help in the early stages of both Associations than Geo. Monro Ltd., and the writer is glad of the opportunity publicly to record our indebtedness.

F.C.A.

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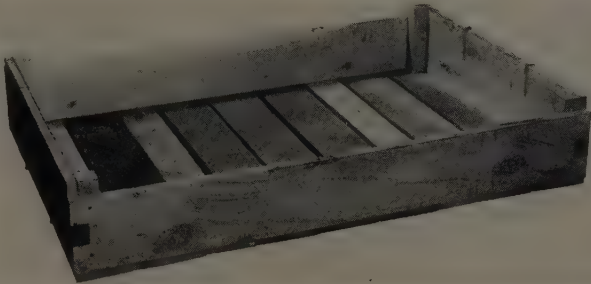
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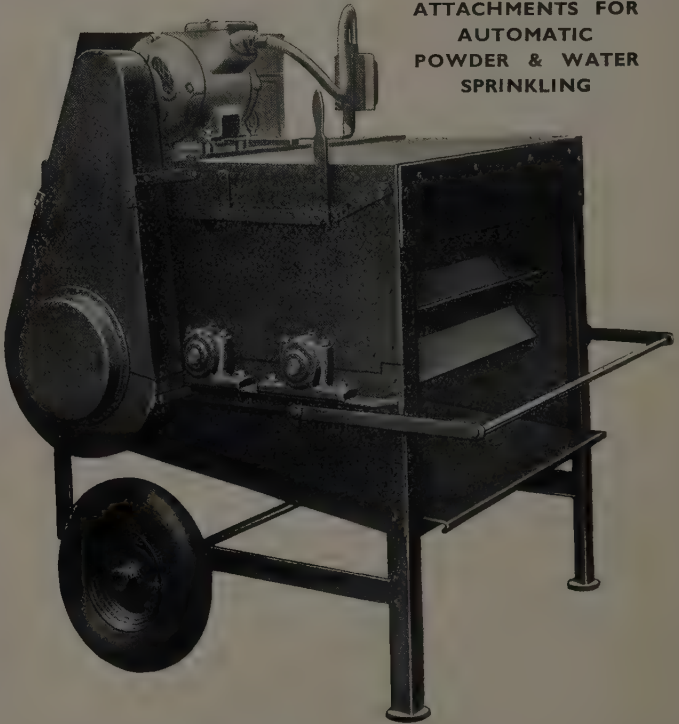
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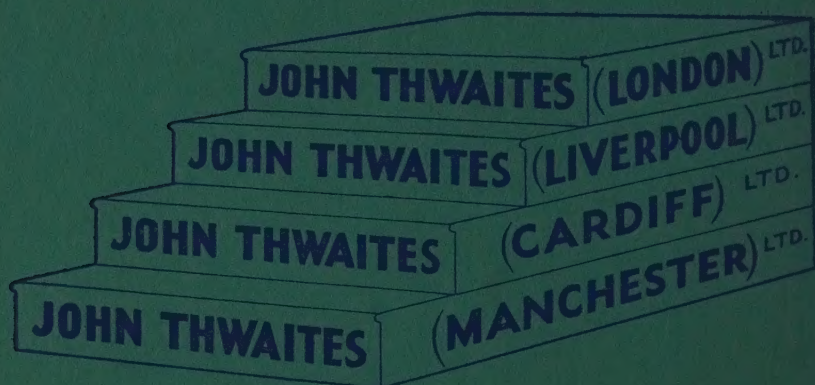
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